SCIENCE.

FRIDAY, DECEMBER 21, 1883.

JOHN LAWRENCE LECONTE.

AMERICAN science has suffered a sad loss in the death of one of its best-known exponents. An advanced leader in his own department, profound and accurate in his labors, a cultured scholar, a genial companion and a true friend, — such a man was LeConte.

Ever sincerely yours
John L. LeConte

John L. LeConte, the son of Major John Eatton LeConte and Mary A. H. Lawrence, was born May 13, 1825, in New-York City. When but a few weeks old, his mother died, and the father thenceforward devoted himself to the care and development of his only child. The father died in 1860, having seen his son rise to a foremost place among the naturalists of his day.

On arriving at suitable age, he was placed in St. Mary's college, Maryland, from which he was graduated in 1842. The discipline of the school was severe, the training accurate and thorough. Early in his pupilage he exhibited decided tastes for natural-history studies outside of the scholastic course, greatly to the alarm of his tutors. The father, on being apprised of this, was greatly pleased, and directed that the tendencies should not be repressed, inasmuch as the boy exhibited no deficiency in his regular studies. His progress in the study of mathematics and languages was rapid and thorough, and doubtless laid the foundation for the accuracy and retentiveness of his memory, so marked in his maturer years. After the completion of the college course, he returned to his native city, and entered the College of physicians and surgeons of New York, receiving his medical degree in 1846.

For many years Major LeConte had been in correspondence with European entomologists, notably Dejean, and laid the foundation of the cabinet, now greatly enlarged, which made the basis of the future labors of the son. In 1844 the first essays of the latter in original work made their appearance, with unmistakable evidences of his youth and inexperience.

During 1849 he made several visits to the Lake-Superior region, once in company with Professor Agassiz, collecting largely, and publishing the results in Agassiz' work on that region. In the autumn of 1850 he visited California, remaining the greater portion of the following year, stopping for a while at Panama, collecting largely in many departments of natural history in a region in which nearly every thing was new to science, extending his explorations through the Colorado desert and as far east as the Pima villages. The material collected in these regions was carefully studied on his return, and the results published in the annals of the New-York lyceum. In 1852 the LeContes removed to Philadelphia, where the greater portion of the scientific labors of both have since been published. For a few months in 1857 LeConte accompanied the Honduras interoceanic survey, under the late J. C. Trautwine, publishing his observations in the report of that expedition. He visited at the same time the Fuente de Sangre, contributing an account of that phenomenon in Squier's 'Nicaragua.'

After these voyages, LeConte's scientific labor was uninterrupted until the breaking-out of the war. In 1862 he was appointed surgeon of volunteers, and shortly after made medical inspector with the rank of lieutenant-colonel; in which position he remained until 1865, exhibiting a capacity for organization and direction in a wider field than the cabinet to which he had hitherto confined himself.

During the summer of 1867 he acted as geologist of the survey for the extension of the Union Pacific railway southward to Fort Craig, under the command of Gen. W. W. Wright. His report, which in no way detracts from his reputation as an entomologist, was published as part of the report of the survey.

In the autumn of 1869 he started for Europe with his family, remaining abroad until near the close of 1872, visiting, in the mean time, Algiers and Egypt. His residence abroad interrupted somewhat his authorship, but not his studies. He visited all the accessible public and private museums; and his wonderful memory of the species of his own cabinet enabled him to settle many doubtful points of synonymy. Those who met him abroad were deeply impressed by his thorough scholarship, and his quick and accurate perception of the affinities of Coleoptera which he had never before seen. On his return he resumed his labors, which continued, with slight interruptions by ill health, until within a week of his death.

LeConte's career in science began in 1844 with his first paper in the proceedings of the Philadelphia academy, followed by others in other journals: these gave but little evidence of the future powers of the man, until, in 1850, his 'Monograph of Pselaphidae' appeared, in which an arrangement of these minute forms was proposed which remains at present the basis of the general classification of these insects. Shortly after appeared his 'Attempt to classify the longicorn Coleoptera of America, north of Mexico,' — a work of far wider application than indicated by its title, in which numerous suggestions of new characters and wider applications of old ones are found.

To follow his papers from this period would be a history of scientific coleopterology in America. Their importance and utility attracted attention abroad, and many were reprinted in whole or in part. As to their scope, they cover nearly every family in the order: and in every case his work is an improvement on what preceded it; he always left a subject better than he found it.

Several of his works require a special notice. His edition of the entomological writings of Say, in which he was assisted in their departments by Baron Osten-Sacken and Mr. P. R. Uhler, proved of inestimable value to students by placing within easy access the works of that pioneer of American science. The volumes appeared in 1859, have run through several editions, and are still in demand. Realizing that his favorite branch needed greater encouragement, he undertook, in 1860, the 'Classification of the Coleoptera of North America,' with the accompanying list of species, and de-

scriptions of new forms. This work was never completed, but extended to the end of the Cerambycidae. The interruption of the work by the war made an interval of time in which the edition of the earlier-issued parts became exhausted, and, to a certain extent, antiquated from more recent studies. The results of this book are abundantly shown in the vast increase in the number of intelligent students and collectors, accompanied by a further demand for the exhausted edition, rendering a new one necessary.

Before the new edition could be prepared, it became imperative to study the Rhynchophora; and at this point LeConte made one of the boldest strokes of his career in the isolation of that series from other Coleoptera, and by proposing a classification of them as remarkable in novelty as it was true to nature. This was followed by the 'Species of Rhynchophora,' published as a separate volume by the American philosophical society.

The preparatory studies having been thus completed, LeConte looked forward with pleasure to an entirely new work to replace the old 'Classification,' and my co-operation was invited in the preparation of monographic essays. Two years ago, his health then slightly failing, he expressed the desire that the authorship of the new work should be equally divided; and in January, 1882, the work was begun. It was completed in March, 1883, in time for him to realize that it had been at least well received. To speak further of this work would, for obvious reasons, be inappropriate: suffice it to say, that his first edition made the ground-work of the second, and his spirit actuated the embellishment of the superstructure.

Since the completion of this work, his health has not admitted of much study; but he continued his work until within a few days of his death, and the incomplete manuscript will be published in the form he desired.

While LeConte's reputation will be based on his entomological writings, he by no means limited himself to this field. Mention has already been made of several important geological contributions. There are others of less moment. He has contributed a number of articles on vertebrate paleontology, and several on existing mammals. His 'Zoölogical notes of a visit to Panama' (*Proc. Philad. acad.*, 1852) illustrate the extent of his study in another direction. At least one article on purely social science has emanated from his pen.

In a general review of his writings, LeConte is found remarkably free from controversial tendencies. He gave to science the best results of his labor, knowing that what was worthy would in time be adopted. I know that he was better pleased to have errors of his own corrected than to correct those of another. He was above the limit of those petty jealousies which too often prevail between active workers in the same field. Those who sought his advice or assistance, either in person or by correspondence, were always made welcome; and the numerous cabinets determined by him gave evidence alike of his industry and liberality. The result of LeConte's labors has been the elevation of coleopterology in America from a traditional knowledge to a science with a permanent and distinctive literature.

LeConte was president of the American association for the advancement of science in 1874; and his address on retiring, regarding the relations of the geographical distribution of Coleoptera to paleontology, opened a new field for the thoughtful student.

No prominent public position was ever held by LeConte. He was urged by his friends for the position of commissioner of agriculture; and, while he received an indorsement of which any man might be proud, the choice of President Hayes gave it to another. That his eminence as a naturalist was recognized is shown in the numerous societies, at home and abroad, of which he was elected a member. Of the entomological societies of London, France, and Berlin, he was made an honorary member, — a distinction attainable by few, from the limited number allowed by the societies' rules. At the time of his death he was president of the American entomological society, and a vice-president of the American philosophical society.

In 1861 Dr. LeConte was married to Helen, daughter of the late Judge Grier, who, with two sons, survives him.

Dr. LeConte died Nov. 15, 1883, and was buried in West Laurel Hill cemetery, in the vicinity of Philadelphia. His death is an irreparable loss to American science, and a calamity in his special department.

GEORGE H. HORN.

THE WEATHER IN OCTOBER, 1883.

THE monthly review of the U. S. signal-service gives in copious detail the weather conditions which prevailed in October. The peculiar features of the month were the deficiency in temperature and excess in rainfall in the greater part of the country. The former was most strongly marked in the Missouri valley and New England, the mean temperature falling below the average 3°.7 and 3°.6 respectively in these districts. In Tennessee, Florida, the Rio Grande valley, the South Atlantic and Gulf states, however, the mean temperature was from 2°.5 to 4°.3 above the average; so that the distribution of temperature was rather irregular. One instance of a maximum temperature of 100° was noted, while the frosts were frequent.

The distribution of rainfall is indicated by the following table: —

Average precipitation for October, 1883.

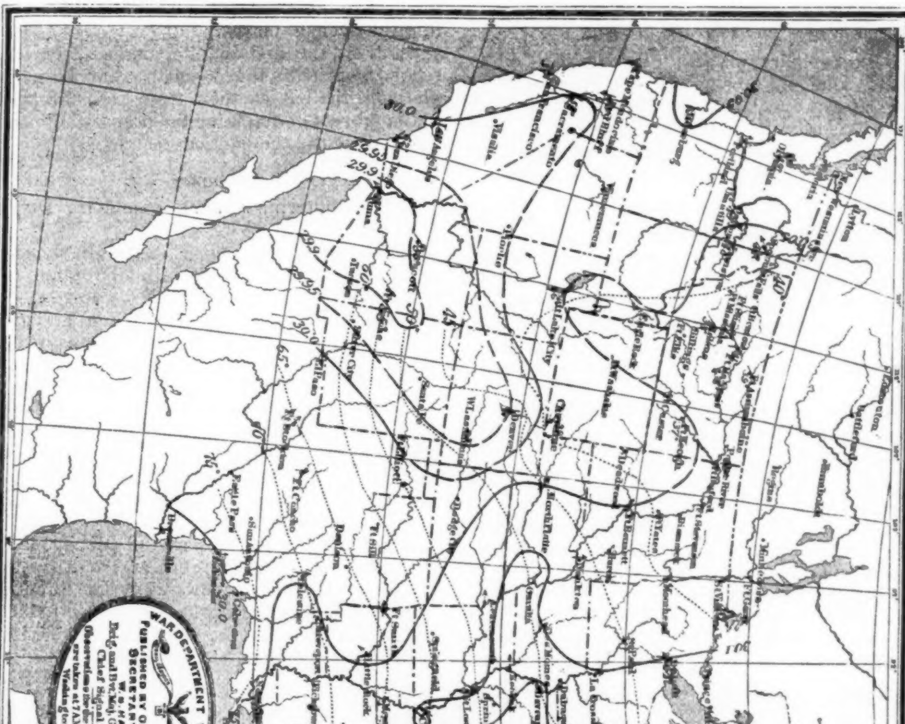
Districts.	Average for October. Signal-service observations.		Comparison of October, 1883, with the average for several years.
	For several years.	For 1883.	
	Inches.	Inches.	Inches.
New England	3.82	6.23	2.41 excess.
Middle Atlantic states	3.07	5.13	2.06 excess.
South Atlantic states	4.77	3.14	1.63 deficiency.
Florida peninsula	6.27	9.09	2.82 excess.
Eastern gulf	3.79	2.51	1.28 deficiency.
Western gulf	3.75	5.23	1.48 excess.
Rio Grande valley	3.86	0.94	2.92 deficiency.
Tennessee	3.42	5.60	2.18 excess.
Ohio valley	3.04	6.75	3.71 excess.
Lower lakes	3.12	2.86	0.26 deficiency.
Upper lakes	3.80	3.62	0.18 deficiency.
Extreme north-west	2.01	2.93	0.92 excess.
Upper Mississippi valley,	3.19	4.82	1.63 excess.
Missouri valley	2.01	4.12	2.11 excess.
Northern slope	0.81	1.94	1.13 excess.
Middle slope	1.26	3.40	2.14 excess.
Southern slope	1.57	2.98	1.41 excess.
Northern plateau	2.50	1.64	0.86 deficiency.
Southern plateau	0.67	0.84	0.17 excess.
North Pacific coast	4.45	3.49	0.96 deficiency.
Middle Pacific coast	1.11	1.71	0.60 excess.
South Pacific coast	0.33	1.16	0.83 excess.

The drought in New England and in some portions of the Southern States was broken by the copious rains of the month, but still continued in other sections.

The storms of the month present some noticeable features. The weather over the North Atlantic Ocean was generally stormy, being attended by a succession of strong westerly breezes. There were seven depressions charted on the ocean, all of which moved in a north-easterly direction. Of these, four were continuations of storms in the United States, one of which moved to the British coast; and one was a tropical hurricane which gave evidence of its presence off the Atlantic coast by high winds at coast stations, and which moved north-eastward as far as the twentieth meridian. Nine depressions were charted in the United States; all, with one exception, moving north-easterly, and but one being a severe storm. This occurred on the 17th and 18th, causing violent gales on Lake Michigan, though few casualties were reported. One depression moved in quite an unusual path: it was reported at Yuma, Arizona, on the 2d, and moved in a northerly direction into British America. There is reason to believe that it was a tropical hurricane which crossed Mexico in the latter part of September from the Caribbean Sea, and, recurving in the Pacific, entered the country in Arizona as a weak depression. All of the tropical hurricanes of this season have run their courses mainly in the ocean. Though they have been fully as numerous and as severe as usual, their ravages have been confined to the islands in their path and to the vessels exposed to their fury.

Sunspots continue to be numerous. There was only one brilliant aurora in October, and this was observed principally in New England and northern New York. Severe shocks of earthquake were experienced in San Francisco on the 9th and 10th, causing considerable alarm, but no material damage. A new volcano has made its appearance, bursting out in Bering Sea: it has been exceedingly active, having already formed an island eight hundred to twelve hundred feet high. On the 20th a shower of mixed sand and water fell at Unalashka, sixty miles east of the volcano, which may have come from it.

The accompanying map represents the mean pressure, temperature, and wind-directions. The former is worthy of note because of the regular increase of pressure from west to east. Usually there are two high areas in October, — one near the eastern coast, and the other in the north-western territories. The latter was wanting in October of this year.



MONTHLY MEAN ISOBARS, ISOTHERMS, AND WIND-DIRECTIONS, OCTOBER, 1883. REPRINTED IN REDUCED FORM BY PERMISSION OF THE CHIEF SIGNAL-OFFICER.

A NEW RULE FOR DIVISION IN ARITHMETIC.

The ordinary process of long division is rather difficult, owing to the necessity of guessing at the successive figures which form the divisor. In case the repeating decimal expressing the *exact* quotient is required, the following method will be found convenient.

Rule for division.

First, Treat the divisor as follows: —

If its last figure is a 0, strike this off, and treat what is left as the divisor.

If its last figure is a 5, multiply the whole by 2, and treat the product as the divisor.

If its last figure is an even number, multiply the whole by 5, and treat the product as a divisor.

Repeat this treatment until these precepts cease to be applicable. Call the result the *prepared divisor*.

Second, From the prepared divisor cut off the last figure; and, if this be a 9, change it to a 1, or, if it be a 1, change it to a 9: otherwise keep it unchanged. Call this figure the *extraneous multiplier*.

Multiply the extraneous multiplier into the divisor thus truncated, and increase the product by 1, unless the extraneous multiplier be 7, when increase the product by 5. Call the result the *current multiplier*.

Third, Multiply together the extraneous multiplier and all the multipliers used in the process of obtaining the prepared divisor. Use the product to multiply the dividend, calling the result the *prepared dividend*.

Fourth, From the prepared dividend cut off the last figure, multiply this by the current multiplier, and add the product to the truncated dividend. Call the sum the *modified dividend*, and treat this in the same way. Continue this process until a modified dividend is reached which equals the original prepared dividend or some previous modified dividend; so that, were the process continued, the same figures would recur.

Fifth, Consider the series of last figures which have been successively cut off from the prepared dividend and from the modified dividends as constituting a number, the figure first cut off being in the units' place, the next in the tens' place, and so on. Call this the *first infinite number*, because its left-hand portion consists of a series of figures repeating itself indefinitely toward the left. Imagine another infinite number, identical with the first in the repeating part of the latter, but differing from this in that the same series is repeated uninterruptedly and indefinitely toward the right, into the decimal places.

Subtract the first infinite number from the second, and shift the decimal point as many places to the left as there were zeros dropped in the process of obtaining the prepared divisor.

The result is the quotient sought.

Examples.

1. The following is taken at random. Divide 1883 by 365.

First, The divisor, since it ends in 5, must be multiplied by 2, giving 730. Dropping the 0, we have 73 for the prepared divisor.

Second, The last figure of the prepared divisor being 3, this is the extraneous multiplier. Multiplying the truncated divisor, 7, by the extraneous multiplier, 3, and adding 1, we have 22 for the current multiplier.

Third, The dividend, 1883, has now to be multiplied by the product of 3, the extraneous multiplier, and 2, the multiplier used in preparing the divisor. The product, 11298, is the prepared dividend.

Fourth, From the prepared dividend, 11298, we cut off the last figure, 8, and multiply this by the current multiplier, 22. The product, 176, is added to the truncated dividend, 1129, and gives 1305 for the first modified divisor. The whole operation is shown thus: —

```
          1883
             6
         -----
         1129|8
          176
         ----
         130|5
         110
         ---
          2|40
         88
         ---
         |90
      -----
       19|8
      176
      ---
       19|5
     110
     ---
      12|9
    198
    ---
     2|10
    22
    --
    24
```

We stop at this point because 24 was a previous modified dividend, written under the form 240 above. Our two infinite numbers (which need not in practice be written down) are, with their difference, —

$$\begin{array}{r} \dot{1}0,958,90\dot{4},058 \\ \underline{\dot{1}0,958,90\dot{4},109.58904\dot{1}095890\dot{4}} \\ 51.58904\dot{1}095890\dot{4} \end{array}$$

Hence the quotient sought is $5.1\dot{5}890410\dot{9}$.

Example 2. Find the reciprocal of 333667. The whole work is here given: —

```
 33366|7                               |7
233567                           163496|9
                                2102103
                                 22655 9|9
                                2102103
                                 232866|2
                                 467134
                                 700000
```

Answer, $.\dot{0}0000299\dot{7}$.

Example 3. Find the reciprocal of 41.

Solution. —

```
  4|1                                 |9
 37|9                               33|3
                                   111
                                    14|4
                                   148
                                    16|2
                                    74
                                    90
```

Answer, $.\dot{0}243\dot{9}$.

C. S. PEIRCE.

URNATELLA GRACILIS, A FRESH-WATER POLYZOAN.

A PAPER on this polyzoan, by Professor Joseph Leidy, has been recently published, with illustrations, in the *Journal of the Academy of natural sciences of Philadelphia.* Urnatella was originally discovered in 1851, and briefly noticed in the Proceedings of the academy the same year, and also subsequently in 1854, 1858, and 1870. It was found in the Schuylkill River at Philadelphia, but has not been seen elsewhere, except a dried but characteristic specimen on the shell of a Unio from Scioto River, Ohio.

Urnatella is an interesting and beautiful form, living in association with Plumatella and Paludicella, and having similar habits, but is very different from them or any other known fresh-water polyzoan, and is most nearly related with the marine genus Pedicellina. It is found attached to the under side of stones beneath which the water can flow. As commonly observed, it consists of a pair of stems divergent in straight lines, or rather gentle curves, from a common disk of attachment. The stems slightly taper, and are beaded in appearance, due to division into segments alternately expanded and contracted. The segments commonly range from two to a dozen, proportioned to the length of the stem, which, when longest, is about the eighth of an inch or a little more. The stems terminate in a bell-shaped polyp, with an expanded oval or nearly circular mouth slanting to one side, and furnished with about sixteen ciliated tentacles. The stems also usually give off a pair of lateral branches from the second segment succeeding the polyp, and frequently likewise from the first segment. The branches consist of a single segment or pedicle supporting a polyp, and usually also give off similar secondary branches. The first and second segments are cylindroid, highly flexible, and mostly striated and colorless, and appear mainly muscular in structure. The succeeding segments are urn-shaped; the body of the urn being commonly pale brown, ringed with lines, and marked with dots of darker brown. The neck and pedicle of the urns are black. The different colors give the stem a beaded and alternately brown and black appearance. Through the lighter colored body of the urns a central cord can be seen, extending through the length of the stem. The urn-shaped segments exhibit lateral pairs of cup-like processes, which correspond in position with the branches from the terminal pair of segments of the stem, and apparently indicate branches which have separated from the parent stem to establish themselves elsewhere as new polyp-stocks.

A series of specimens of Urnatella — from such as consist only of a simple cylindrical, flexible pedicle, supporting a polyp, to those with long stems, consisting of a dozen segments — indicates the urn-shaped segments to be formed successively through segmentation of the originally single simple pedicle. The segments, therefore, do not correspond with what were polyps; but the terminal polyp is permanent, and the segments originate by division from its neck, very much as the segments of the tape-worm arise from its head. After the destruction of the head, the segmented stem remains persistent; but what becomes of it ultimately has not been determined. Probably the segments may serve the purpose of the statoblasts of other fresh-water polyzoa, but the question has not

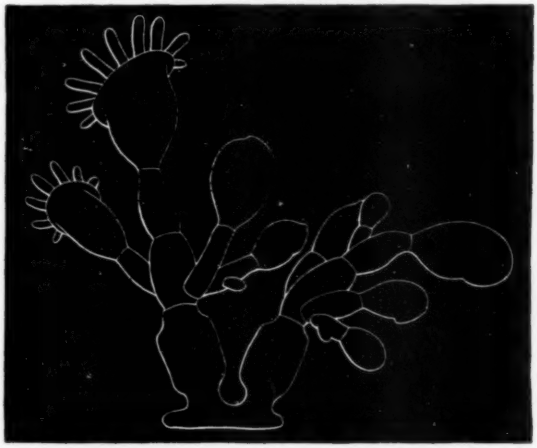


FIG. 1. — Urnatella gracilis. The one on the left with the polyps expanded; that on the right in the condition assumed when the animal is disturbed.

been ascertained. A common mode of propagation of Urnatella appears to be by budding, the formation of branches with their terminal polyps, and the detachment of these branches to establish stocks elsewhere. The different specimens apparently indicate this process, though it was not actually observed.

Though the stem of Urnatella is invested with a firm, chitinous integument, it still retains its flexibility; so that, when the polyp is disturbed, it not only closes its bell, and bends its head, but the entire stem bends, or even becomes revolute. Sometimes the polyps suddenly twist the stems from side to side, as

FIG. 2.—Urnatella gracilis, with the main stem of four segments, and a terminal expanded polyp. Branches are given off by the third segment, and a bud from the fourth.

if they had become wearied of remaining longer in the same position.

The interior of the polyp is mainly occupied by the alimentary apparatus. From the mouth of the bell a funnel converges as the pharynx; and the tube of the former, as the oesophagus, occupies the shorter side of the bell. At the bottom of the latter the oesophagus opens into a capacious retort-like stomach, which occupies two-thirds of the capacity of the polyp. The stomach towards the mouth of the bell has an alembic-like pylorus, from which a short intestine turns ventrally to expand in an oval colon. From this a short rectum opens about the centre of the mouth of the bell. The pharynx, oesophagus, and stomach are lined with ciliated epithelium. The ventral side of the stomach has the epithelium colored brown, indicating, as in other polyzoa, an hepatic function. The polyp feeds on vegetable particles mainly, including diatoms, desmids, etc.; and the food may be observed in an incessant whorl in the axis of the stomach, induced by the action of the cilia lining the latter. The polyp is almost constantly infested with parasites, often in large numbers, which mingle with the food, and accompany this in its movement. The parasite is a ciliated infusorian, distinguished with the name of Anoplophrya socialis. From time to time, remains of the food are passed into the colon, and here accumulated into an oval pellet, which is then quickly discharged from the mouth of the bell.

Generative organs, or provision of any kind for the production of ova, were not detected, nor were eggs observed.

Urnatella differs from the marine genus Pedicellina mainly in not having an attached and creeping rootstalk, and in having free, pendent, and jointed stems, instead of simple pedicles.

THE PHYLOGENY OF THE HIGHER CRUSTACEA.

THE class Crustacea is one of the dominant groups of the animal kingdom, and it includes a very considerable proportion of our living animals. Its representatives are extremely diversified in structure; and a single order, such as the Decapoda, includes a much greater variety and diversity of forms than the whole class of insects. It is very rich in primitive and transitional forms; and when we add to this, that there is no group in which our embryological knowledge is more rich and varied, or in which the embryological history of the individual throws so much light upon the evolution of the race, its importance as a means for tracing the actual history of the evolution of species is obvious. In fact, most of the problems in the logic of morphological reasoning, are, in great part at least, problems in the morphology of the Crustacea.

Since the awakening in natural science which followed the publication of the Origin of species, many naturalists have attempted to disentangle the story of the phylogeny of the Crustacea. Some of these attempts, such as Müller's 'Für Darwin' and Huxley's 'Crayfish,' are familiar to all; while others, such as Claus' 'Crustaceen system,' are known to none except specialists. The latest attempt in this field ("Studien über die verwandtschaftsbeziehungen der Malakostraken," by Dr. J. E. V. Boas, *Morph. jahrb.*, viii. 4, 1883) is, to say the least, a very valuable addition to crustacean morphology, as well as an interesting study in scientific logic. Its results seem to be a close approximation to the true natural classification of the higher Crustacea, and it should therefore receive the careful attention of all naturalists, and of all who wish to be informed regarding the methods of thought in morphology; but as it is from necessity filled with minute details, which would be formidable to all except specialists, the general reader must be contented with a summary of the results.

The proof that the crabs are descended from long-tailed decapods is familiar to all naturalists; and no one can doubt, that, among these, the swimming dec-

apods, such as Penaeus, are the most primitive. So far, the phylogeny of the decapods may be regarded as definitely settled, and Boas proposes no modification of the accepted view; but his opinion regarding the origin of the swimming decapods from the lower Crustacea is novel, and the evidence which he furnishes seems to be conclusive. The Decapoda are generally regarded as the modified descendants of the schizopods; but Boas points out that the order Schizopoda is not a natural group, since the animals which have been included in it belong to two widely separated orders.

According to this author, the Euphausiacea and the Mysidacea are not at all intimately related. The latter are not in the line which leads to the Decapoda, and there is no natural group Schizopoda. He therefore divides the group into two orders, — the Euphausiacea and the Mysidacea: the former including the primitive unspecialized forms through which the Decapoda have been evolved from the lower Crustacea; and the latter containing highly specialized forms, which have been evolved from the Euphausiacea along an independent line, and which have no direct relationship to the Decapoda. He holds, that the Euphausiacea are a synthetic group of Crustacea which has given rise to several divergent groups of descendants. Of these, the decapod stem has undergone the least modification. A second stem, the Mysidacea, has diverged in an entirely different direction, has departed very widely from the primitive form, and has, in its turn, given rise to the Cumacea, and through these to the amphipods and isopods, the latter being the most highly modified of the Malacostraca. A third line of descent from the Euphausiacea has given rise to the Squillacea.

The recognition by Boas of the fact, that the group Schizopoda is not a natural one, and the discovery that the animals which have been thus associated may be divided into a very primitive group, the Euphausiacea, and a highly specialized group, the Mysidacea, seems to be a very great advance in crustacean morphology.

He gives the following definition of the Euphausiacea:—

Malacostraca, with the mid-body and abdomen compressed, with a well-marked bend in the abdomen; carapace well developed; the last segment of the mid-body a complete ring; eyes stalked; antenna with a large scale; mandible simple; first maxilla with broad, one-jointed palp, and with well-developed exopodite; second maxilla with a similar palp, and with exopodite, and a cleft lacinia interna. The appendages of the mid-body or cormopods all have a well-developed exopodite, and an epipodite which is subdivided in all except the first pair, where it is simple. The endopodite is thin and weak, and it does not end in a sharp point: it is more or less rudimentary on the last two pairs. The first cormopods are not specialized as maxillipeds, but are like the others. The abdominal feet are powerful swimming-organs, with an appendix interna. In the male the first or most anterior ones are specialized as copulatory organs. The tail-fins are well developed. The liver is composed of a great number of small lobes. The heart is short and wide. The halves of the reproductive organ are united by a transverse unpaired portion. Spermatophores are present, and the spermatozoa are simple round cells. There is an antennary gland. The young leaves the egg as a free-swimming nauplius, and the carapace of the older larva is a great phyllopod-like mantle.

It is easy to trace the relationship between this group and the decapods, on the one side, and, on the other side, through Nebalia, to the phyllopods and lower Crustacea.

The Decapoda natantia resemble the Euphausiacea in many conspicuous and highly important particulars. In these two groups alone, among the Malacostraca, we have a free-swimming nauplius; and in both the carapace of the larva is a great mantle. The abdomen is bent in both, and the integument is horny. The carapace, the abdominal appendages, the large tail-fin, and the pointed telson, are alike in both. The endopodite of the first pleopod is a copulatory organ in the decapods as well as in the Euphausiacea; and spermatophores are almost universal in these two groups, while they are found in no other Malacostraca.

The close relationship between these two groups can hardly be questioned; nor is it difficult to show that the Euphausiacea are the primitive, and the Decapoda the derived, form. In the presence of simple epipodites, and of a four-jointed palp on the first maxilla, the Penaeadae are nearer to the phyllopods than Euphausia; but in all other respects Euphausia is the most primitive, and it shows its close relationship to the lower Crustacea by many characteristics, among which are the following. The terminal joint of the cormopods is rounded and blunt, as it is in Nebalia, instead of being pointed, as it is in all the Malacostraca except Nebalia. There are no specialized maxillipeds; but the first cormopod is like all the others, as it is in Nebalia, and all the cormopods are furnished with exopodite and epipodite: while in all other Malacostraca there are true maxillipeds; and either the exopodites or the endopodites, or both, are absent on some or on all the cormopods. The antenna has a well-developed exopodite; and in the young this is flabellum-like, and very similar to that of the adult Limnadia or Estheria. This feature of resemblance to the lower Crustacea is shared by the young of the Decapoda natantia. The first maxilla has a large exopodite; while this is rudimentary in the Decapoda and Mysidacea, the only other Malacostraca where it occurs at all. The pleopods are much like those of Nebalia: they are efficient swimming-organs, and they are provided with an appendix interna. The spermatozoa, like those of the phyllopods, are simple round cells without tails; and this is true of no other Malacostraca except the squillas.

While the Euphausiacea are thus seen to be very much like the phyllopods in so many important features, they are true Malacostraca; and they have deviated greatly from their phyllopod ancestor, and have acquired a small carapace, differentiated cormopods with long slender endopodite, small exopodite divided into shaft and flabellum, and an epipodite

which is purely respiratory. They also differ from Nebalia in the possession of that distinctively malacostracan organ, a tail-fin, made up of a telson and a pair of swimmerets.

The relationship of Nebalia to the Malacostraca on the one hand, and to the phyllopods on the other, has long been recognized, and Claus has even gone so far as to hold that this form is a true malacostracan; but Boas believes that it is neither a true malacostracan, nor the phyllopod from which the Malacostraca originated, but simply the nearest living ally of this ancestral form.

He believes that the presence of a great mantle-like carapace, of eight unspecialized, broad cormopods with leaf-like exopodites, of a furcated abdomen without tail-fins, and of eight abdominal somites, show that it is not a malacostracan, but a phyllopod. As many phyllopods, such as Limnetis and the Cladocera, have, like the Malacostraca, an exopodite on the second antenna, we must believe that the Malacostraca have inherited this feature from their phyllopod ancestor; and, as it is absent in Nebalia, this form cannot be the direct ancestor of the Malacostraca. So, too, the fifth and sixth pairs of abdominal feet are rudimentary in Nebalia, while they are well developed in nearly all Malacostraca. As most of the phyllopods, and some of the Malacostraca, leave the egg as a free-swimming nauplius, we must believe that this was true of the phyllopod ancestor of the Malacostraca; but as Nebalia does not pass through a free nauplius stage, but leaves the egg in a more advanced condition, it cannot be in the direct line of evolution. Boas therefore concludes that Nebalia is a true phyllopod, and that the Malacostraca have originated from a form somewhat different, although Nebalia is the closest living ally of this ancestral form.

Having thus traced the decapods back through the Euphausiacea to a phyllopod ancestor very similar to the recent Nebalia, we have now to trace the ancestry of the other Malacostraca. Boas holds that the squilloids are a branch from the Euphausiacea, and that the Mysidacea have been derived from the Euphausiacea along still another line of descent, and have, in their turn, given rise to all the remaining groups of Malacostraca.

The Mysidacea differ from the Euphausiacea and the decapods in many features which they show in common with the Cumacea and the amphipods and isopods; and it is not difficult to show, that, in these points of difference, the Euphausiacea are the primitive group, and the Mysidacea the modified group.

In Euphausia, as in the swimming decapods, the body and abdomen are compressed; while they are flattened and rounded in the Mysidacea, and the tip of the abdomen is directed backwards, lacking the peculiar bend of Euphausia and Penaeus.

The structure of the mandible is very instructive. In Mysis, as well as in the Cumacea and amphipods and isopods, the mandible is forked, the cutting part being widely separated from the crushing part; and between the two there is a row of setae, and a peculiar accessory appendix. In Euphausia and the decapods the appendix and row of setae are absent, and the chewing part is hardly separated from the crushing part. In Mysis, as in Cuma and the amphipods and isopods, the palp and exopodite of the first maxilla are absent, and the laciniae are turned forwards as well as inwards; and in all these forms the laciniae of the second maxilla are directed forwards. They overlap, and the lacinia interna is undivided. In Euphausia, the decapods, and squillas, there are no brood-pouches; but these structures are present in Mysis, as well as in the Edriophthalmata, and they are formed in essentially the same way in all, — by plates which are developed on the basal joints of certain of the cormopods. In all these forms the young pass through a long metamorphosis within these pouches. The liver is comparatively simple. There are no spermatophores, and the spermatozoa have tails. The Cumacea are regarded by Boas as a greatly modified offshoot from the Mysidacea; and the amphipods and isopods are derived from an ancestral form somewhat like, but more primitive than, the living Cumacea.

As regards the position of the amphipods and isopods, Boas's view is directly opposite to that which has been generally accepted; as he regards these as the most highly specialized and divergent of the Malacostraca, instead of low and primitive forms. The conspicuous segmentation of the nervous system, the absence of a carapace, the sessile position of the eyes, the great number of similar somites, the worm-like shape of the body, and the elongation of the heart, — all seem at first sight to show that these forms are ancient and low. Boas points out that the nervous system gives no proof of a primitive condition, as there are as many independent ganglia in Mysis as there are in the sessile-eyed Crustacea. It is true that the heart is longer than it is in Mysis; but there are only three pairs of ostia, and the length of the heart, as compared with that of the mid-body, is no greater than it is in Mysis. As the eyes are stalked in Nebalia, the nearest ally of the Malacostraca, all of the latter must have inherited stalked eyes from their phyllopod ancestors, and the sessile eyes of the Edriophthalmata must be due to secondary modification. So, too, regarding the absence of a carapace. As the Malacostraca inherit this structure from the phyllopods, those forms in which it is absent must have lost it by secondary modification. The same thing is true of the absence of a scale on the antenna. There is, therefore, no proof that these animals are primitive; and the many points of resemblance to the Mysidacea which we have just noticed show the close relationship between these groups. But as the Mysidacea, like Euphausia and the decapods, have stalked eyes, a carapace, and a fused mid-body, exopodites in first maxillae, exopodites and palpi in second maxillae and on cormopods, and as a seventh abdominal segment is present, we must believe that the Mysidacea are the more primitive group, and the Edriophthalmata their recently modified and highly specialized descendants.

Boas believes that most of these differences are due to the fact that the Edriophthalmata have become

adapted for running instead of swimming; and he thus explains the loss of the exopodites of the cormopods, the strengthening of the endopodites, the shortening of the abdomen, the loss of power in the pleopods, the flatness of the body and abdomen, the thickening of the integument, and the loss of eye-stalks and of the antennary scale. The respiratory function of the pleopods he attributes to the loss of the carapace, and the thickening of the integument.

The general conclusions of this highly suggestive and interesting paper may be summarized as follows.

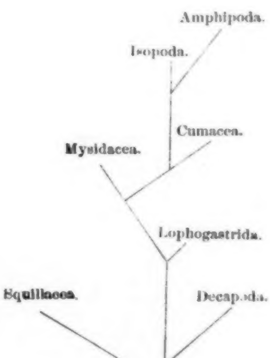
The Malacostraca are descended from the phyllopods, among which Nebalia is their nearest relative.

The Euphausiacea are the most primitive Malacostraca. The decapods originated from the Euphausiacea, although the most primitive decapods, the Natantia, are now widely separated from this ancestral form. The Squillacea stand by themselves, their nearest, although distant, allies being the Euphausiacea. They show in certain points a more primitive condition than any other Malacostraca; although, as a whole, they are highly modified.

The Mysidacea are also derived from the Euphausiacea; although they are so different from them that they must be placed in a distinct order, and the group Schizopoda must be abandoned. The Mysidacea have no close relationship to the decapods.

The Cumacea arise from the Mysidacea, and the amphipods and isopods from a form between the Mysidacea and the Cumacea. The amphipods and isopods are not a primitive group distantly related to the Podophthalmata, but they are the most highly specialized of the Malacostraca.

He gives the following as his phylogenetic classification of the Crustacea: —



W. K. BROOKS.

LETTERS TO THE EDITOR.

Radiant heat.

MR. FITZGERALD has favored me with a paper[1] in which he takes exception to my views respecting radiant heat,[2] wherein he says, —

> "Suppose that two regions, A and B, be separated by three parallel screens, l, m, and n, having apertures in them, x, y, z, capa-
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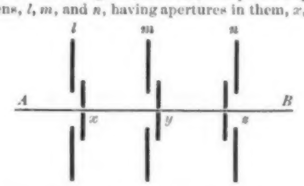
> 
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>
> ble of being opened and closed from the centre, so as to make every thing perfectly symmetrical round the line AB, perpendicular to the screens. Now, if x be opened for a very short time, a certain quantity of radiant energy will escape out of A into the region between l and m; and if y be opened when this heat reaches m, it can certainly be let on into the region mn; and if z be similarly opened when it reaches it, this radiant heat will get into B. While z was open, however, some heat left B; but, as Dr. Eddy observes, y may be closed so as not to let this even get through the screen m, and it can be all returned into B by reflection through z or some other aperture. So far I entirely agree with Dr. Eddy, and so far it seems as if the result had been to transfer heat from A to B without B's losing any heat by having it transferred to A. As I warned Dr. Eddy when I heard his paper, there are, however, other bodies and regions to be considered besides A and B. There are more than two bodies considered: there is the region of the screens. Consider what happens when the heat that escaped out of B into the mn region tries to get back into B. Some door must be opened to let it pass; and, while it is passing in, an at least equal amount of heat will be passing out of B into the mn region, so that you can never really get the heat that has once left B back into B again. This is true, whether you adopt doors over fixed apertures, such as I have supposed, or moving apertures, such as Dr. Eddy proposed. What really takes place is this: a certain quantity of heat escapes out of A and reaches B; and a not less quantity of heat leaves B, and is kept entangled in the region of the screens, and it is only possible to let the heat pass from A to B by means of this third region. Hence this only really comes to the same thing as letting A radiate some of its heat into the screen region, while B is kept closely shut up. Now, be it observed that Dr. Eddy practically postulates that this screen region is at least colder than A — in fact, he assumes it to be perfectly cold, i.e. to contain no radiant heat except what is admitted from A and B, so that it is by no means contrary to the theory of exchanges that A might cool by radiating into this region."

Now, Mr. Fitzgerald has stated only two of the three things which occur while the door z is open. He omits to state, that in my process a certain amount of heat which has come from A also passes through the door z every time it is opened, into the region B; and this is all which is proposed to be accomplished by the process which is at all unusual or peculiar. Thus the fact remains, that although a definite amount of heat from B remains entangled in the region mn, which is not increased with the lapse of time, there is a continued passage of heat through this region into B, that being the very object sought to be accomplished by my process. It is not easily seen how the arrangement of screens and apertures proposed by Mr. Fitzgerald could be so manipulated as to bring the heat coming from A into a position such

[1] On Dr. Eddy's hypothesis that radiant heat is an exception to the second law of thermodynamics. By George F. Fitzgerald, M.A., F.T.C.D., *Sc. proc. roy. Dubl. soc.*, iv. pt. i.
[2] *Sc. proc. Ohio mech. inst.*, July, 1882.

that it would be in readiness to pass into B at the same time as the heat which originally came from B is returned to B, though my arrangement of moving screens readily accomplished this, as was admitted by Prof. J. Willard Gibbs in his criticism of my paper.[1]

H. T. EDDY, Ph.D.

Area of a plane triangle.

In the *Mathematical magazine* (Erie, Penn.) for April, Mr. James Main publishes, as a matter of curiosity, a collection of ninety-four expressions for the area of a plane triangle. In *Mathesis* (Gand, Belgium) for June this list is republished; and in the August number of the same journal the subject is taken up again by M. Ed. Lucas, who extends the collection, and classifies into five groups. In the first group are eleven '*unique*' expressions for the area, i.e., expressions that do not admit of other similar expressions by permuting the letters; in the second group are nine expressions, each admitting of two other similar expressions by permuting the letters; in the third group are eleven expressions, each admitting of three other similar expressions; in the fourth group are seven expressions, each admitting of five similar expressions; and, last, the fifth group consists of a single formula, admitting of eleven similar expressions. Thus we have a hundred and thirty-six expressions for the area of a plane triangle in terms of the sides, angles, perpendiculars, semiperimeter, and radii of the circumscribed, inscribed, and escribed circles. M. Neuberg adds also three other unclassified formulae, with the statement that many other such may be found. The total number of expressions for the area of a plane triangle, in this collection, is therefore a hundred and thirty-nine, making it, perchance, the most complete collection that has been published.

M. B.

The Dora coal-field, Virginia.

In the November number of *The Virginias* is contained a review of the report on the mineral resources of the United States, recently published by the U.S. geological survey, which contains the following:—"In Mr. Charles A. Ashburner's report on anthracite coal, p. 32, is this statement concerning the Dora coal-field: 'Of one of the reported anthracite localities in Virginia, that in Augusta county, recent tests with the diamond-drill would seem to prove the presence of anthracite,'" etc. In explanation of the above, I would like to state, that, by referring to the report reviewed, on p. 24 will be found a footnote as follows: "Mr. Ashburner's contribution and statistics end here." I only stand responsible for a *portion* of the statistics relating to the anthracite region in Pennsylvania (pp. 7 to 24 inclusive). I desire to make this explanation public from the fact that I do not wish to be held accountable for *questionable data* relating to a coal-field of a very uncertain character, and which I have never examined.

CHARLES A. ASHBURNER,
Geologist in charge Penn. anthracite survey.

Philadelphia, Penn.

Synchronism of geological formations.

In SCIENCE of Dec. 7 your correspondent, Mr. Nugent, takes issue with me as to my conclusions bearing upon the relative ages of geological formations, and contends that the geological and paleontological researches of the last twenty-one years (i.e., during the period that has elapsed since the publication of Professor Huxley's address referred to in my communication before the Philadelphia academy of natural sciences) have only tended 'to maintain the logical basis' on which the distinguished English naturalist rested. As the subject is a very important one, and one that has not, it appears to me, received its full measure of attention or discussion, I trust that you will permit me a little space for fuller explanation, even at the risk of repeating what has already been said in your valuable columns.

Professor Huxley, in his anniversary address delivered before the London geological society in 1862 (*Quart. journ.*, xviii. p. xlvi), maintains substantially,—

I. That formations exhibiting the same faunal facies may belong to two or more very distinct periods of the geological scale as now recognized; and, conversely, formations whose faunal elements are quite distinct may be absolutely contemporaneous: e.g., "For any thing that geology or paleontology is able to show to the contrary, a Devonian fauna and flora in the British Islands may have been contemporaneous with Silurian life in North America, and with a carboniferous fauna and flora in Africa" (*loc. cit.*).

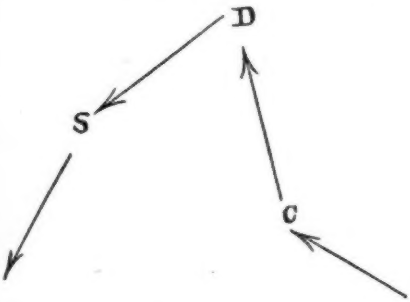
II. That, granting this disparity of age between closely related faunas, all evidence as to the uniformity of physical conditions over the surface of the earth during the same geological period (i.e., the periods of the geological scale), as would appear to be indicated by the similarity of the fossil remains belonging to that period, falls to the ground. "Geographical provinces and zones may have been as distinctly marked in the paleozoic epoch as at present; and those seemingly sudden appearances of new genera and species which we ascribe to new creations may be simple results of migration."

Now, without wishing to enter into the minutiae of the question, I believe a little reflection will clearly show, that if, as it is contended, several distinct faunas (i.e., faunas characteristic of distinct geological epochs, and separated in age from each other by possibly millions of years) may have existed contemporaneously, "evidences of inversion," to quote my own words, "in the order of deposit, ought to be common; or, at any rate, they ought to be indicated somewhere, since it can scarcely be conceived that animals everywhere would have observed the same order of direction in their migrations." Given the possible equivalency in age, as hypothetically claimed, of the Silurian fauna of North America with the Devonian of the British Isles and the carboniferous of Africa, or any similar arrangement, why has it never happened, it may be asked, that when migration, necessitated by alterations in the physical conditions of the environs, commenced, a fauna with an earlier life-facies has been imposed upon a later one, as the Devonian of Great Britain upon the carboniferous of Africa, or the American Silurian upon the Devonian of Britain? Or, for that matter, the American Silurian may have just as well been made to succeed the African carboniferous. Reference to the annexed diagram, where D represents a Devonian area, say, in Europe, S a Silurian one in America, and C a carboniferous one in Africa,—all contemporaneous,—will render this point more intelligible.

Now, on the proposition here stated, reasoning from our present knowledge of the antiquity of faunas, and accepting the doctrine of migration, as maintained by Professor Huxley and others, to account for the possible contemporaneity of distinct faunas, it may be assumed that S (or America) will receive its Devonian fauna from D; D (Europe), its carboniferous from C; and C (Africa), a later fauna from some locality not here indicated. In other words, a migra-

[1] SCIENCE, i. 160.

tion, as indicated by the arrows, would set in from D to S, one from C to D, one from S to some possibly South American Cambrian locality, and one, bringing a Permian or some later-day fauna, from an unknown locality towards C. Were this order of migration to continue here, or at other portions of the earth's surface, in this or in a similarly consecutive manner, the results obtained would be in perfect consonance with the facts presented by geology. But is there any reason whatever for the continuance of this order of migration? Surely no facts that have as yet been brought to light argue in favor of a continued migration in one direction. Why, then, it might justly be asked, could not just as well a migration take place from S to D, and impose with it a Silurian fauna upon a Devonian? What would there be to hinder



a migration from S to C, placing the American Silurian fauna upon the carboniferous of Africa? Why, as I have asked, has it just so happened that a fauna characteristic of a given period has *invariably* succeeded one which, when the two are in superposition all over the world (as far as we are aware), indicates precedence in creation or origination, and *never* one that can be shown to be of a later birth? Surely these peculiar circumstances cannot be accounted for on the doctrine of a fortuitous migration. And it certainly cannot be claimed that through a process of transmutation or development, depending upon the evolutionary forces, a fauna with a Silurian facies will, in the course of a possible migration toward a carboniferous locality, have assumed a carboniferous or Permian character.

The facts of geology and paleontology are, it appears to me, decidedly antagonistic to any such broad contemporaneity or non-contemporaneity as has been assumed by Professor Huxley; and their careful consideration will probably cause geologists to demur to the statement that "all competent authorities will probably assent to the proposition that physical geology does not enable us in any way to reply to this question: Were the British cretaceous rocks deposited at the same time as those of India, or are they a million of years younger or a million of years older?"

ANGELO HEILPRIN.

Academy of natural sciences,
Philadelphia, Dec. 8.

THOMSON AND TAIT'S NATURAL PHILOSOPHY.[1] — II.

BEFORE proceeding to an account of the rest of the work, we shall add a few more words of explanation upon the harmonic solutions of the differential equation (6), expressed in polar co-ordinates. On attempting to integrate this equation, it is found that there is an infinite number of particular solutions, as was before stated must necessarily be the fact; and each of these solutions is the product of three factors. One factor is an arbitrary constant; another factor is the radius vector raised to any integral power, positive or negative; and the remaining factor is a function of the angular co-ordinates, dependent for its form upon the exponent of that power of the radius vector by which it is multiplied. It is this last factor, or coefficient, which gives the name of 'spherical harmonics' to the solution: indeed, these functions of the angular co-ordinates are themselves surface-harmonics.

If we restrict ourselves, as is usually done, to real integral powers of the radius vector r, positive and negative, then, from the well-known principle that a general solution is obtained by taking the sum of particular solutions, we should have the most general possible solution by taking the sum of a series of particular solutions, such as have just been described, in which the powers of r have all integral values between $+\infty$ and $-\infty$. But since it is found, upon computing the functions of the angular co-ordinates which constitute their coefficients, that the coefficients of r^i and $r^{-(i+1)}$ are identical, it will be more convenient to write the general solution in the form —

$$\begin{aligned} V = a_0 f_0(\theta,\phi) &+ (a_1 r + b_1 r^{-2}) f_1(\theta,\phi) \\ &+ (a_2 r^2 + b_2 r^{-3}) f_2(\theta,\phi) + \dots \\ &+ (a_i r^i + b_i r^{-(i+1)}) f_i(\theta,\phi) + \dots \quad (8) \end{aligned}$$

In applying this to any given case, either all the arbitrary constants a vanish, or all the constants b; thus giving rise to the two general forms of solution before mentioned, in which there is a series of terms, either in ascending integral powers of r, or of descending integral powers of r.

A value of V consisting of several terms is a compound spherical harmonic of the degree (positive or negative) of its numerically highest power of r. A value of V consisting of a single term is a simple harmonic.

Returning, now, to the consideration of chapter vii. p. 98, entitled 'Statics of solids and fluids,' the subject of rigid solids is disposed of in the course of thirty pages, nearly half of which is occupied with inextensible strings in the form of catenaries of various kinds.

The authors hasten on to the more intricate matter of elastic solids. As is well known to students of this subject, the general problem

[1] Concluded from No. 36.

of finding the displacements in all parts of an elastic solid of any figure subjected to the action of known forces applied to its exterior surfaces, even when the solid is uniform in texture in all directions (i.e., isotropic), transcends at present the powers of analysis, though considerable progress has been made toward a complete theory. An important contribution to this theory by Sir William Thomson is found on pp. 461 to 468 in Appendix C, entitled 'Equations of equilibrium of an elastic solid deduced from the principle, energy.'

By reason of the incompleteness of the general theory, those simple cases are first treated which are most completely amenable to analysis. The forty pages succeeding p. 130 treat the special case of the elastic wire, whose fundamental equations were first thoroughly investigated by Kirchhoff in 1859. This treatment, which is of interest both to the mathematician and engineer, investigates not only the spirals which elastic wires of circular and of rectangular cross-section assume under the action of direct forces, and of couples producing bending and twisting, but also goes into several important side-issues, one of which is the so-called kinetic analogy. A simple case of this, which is discussed at length, exists between the plane curves assumed by a thin flat spring, and the vibrations of a simple pendulum which it graphically represents. Another important side-issue is found in the discussion of the common spiral spring, in which the force resisting elongation is mostly due to torsion of the wire. Very curiously, the theorem of three moments of a straight beam is omitted, although the principles to be employed in establishing it are fully given.

Another important elastic solid which is fully amenable to analysis is the thin elastic plate. The treatment of the thin plate, which occupies thirty pages, discusses the flexure of a plane plate under all combinations of forces tending to produce either a state of synclastic stress (i.e., a state in which the curvature at every point is convex) or a state of anti-clastic stress (i.e., one which tends to cause the surface to become saddle-shaped). Kirchhoff's boundary conditions for a plate are also demonstrated at length. These are of importance in most practical cases, — as, for example, that of the flat steam-boiler head; for evidently any plate must have some kind of support or fastening at its boundary.

The general subject of elastic solids is reached at p. 204, and occupies a hundred pages, in which, after the general equations of equilibrium between the applied stresses and the resulting strains are established, several special cases are treated at length. The first of these is the celebrated torsion problem published by St. Venant in 1855; in which the distribution of the stresses and strains throughout a right prism of any cross-section whatever, under the action of forces applied to its ends, is completely determined. This is perhaps the most complicated problem which has been entirely worked out in the subject of elastic solids, and twenty-four pages are devoted to it. The flexure of beams having rectangular cross-sections is discussed, especially with reference to the distortions which are suffered by these cross-sections. The distortions can be easily exhibited by bending a thick rectangular piece of rubber, when the upper and lower surfaces will become saddle-shaped.

The general problem is then further treated by investigating the case of an infinite elastic solid under various suppositions as to the force applied through limited and through unlimited portions of it. The spherical and cylindrical shells are then treated by the help of harmonic analysis.

The concluding hundred and sixty pages of the work, beginning at p. 300, are devoted ostensibly to hydrostatics; but the first twenty-five pages finish those parts of the subject included under that title in ordinary treatises, and the remainder relates to the physics of the earth as dependent upon its fluid condition, past or present. The first great problem in this department of inquiry is to determine what figure will be assumed by a rotating liquid mass under the influence of centrifugal force and of the mutual gravitation of its parts. That an oblate spheroid is a figure of equilibrium for such a mass is commonly known, having been shown to be such by Newton; but that an ellipsoid with three unequal axes is also such a figure is not so commonly known, though this was discovered to be the fact by Jacobi in 1834. There are other possible figures, stable and unstable; but which of all these is the one which will actually be assumed in any given case? In reply to this question, the authors state, that "during the fifteen years which have passed since the publication of the first edition we have never abandoned the problem of the equilibrium of a finite mass of rotating incompressible fluid. Year after year, questions of the multiplicity of possible figures of equilibrium have been almost incessantly before us; and yet it is only now, under the compulsion of finishing this second edition of the second part of our first volume, with the hope for a second volume abandoned, that we have suc-

ceeded in finding any thing approaching full light on the subject" (p. 332). Then follows an enumeration of the possible forms of equilibrium, including the single and multiple rings into which an ellipsoid would be changed when rapidly rotated, and the detached portions, nearly spherical, into which an elongated ellipsoid must separate when rapidly rotated about its shorter diameter.

Now, on the supposition that the figure of the earth is approximately an oblate spheroid, the next matter of importance is to show how to compute the alterations in figure due to local inequalities in its density, and irregularities in the distribution of the material composing it. This at once raises the question as to what we are to consider as the surface of the earth at any point which forms part of its figure. The true figure of the earth may be taken to be the water-surface when undisturbed by tides. Whenever it is desired to find such surface on land, a canal could be supposed to be cut from the ocean to the place under consideration. Of course, a plumb-line is everywhere perpendicular to such a surface, whose outline is evidently affected by all existing inequalities of density and distribution of the substance of the earth. For example: it is computed that a set of several broad parallel mountain chains and valleys, which are twenty miles from crest to crest, and seventy-two hundred feet above the bottom of the valleys, would cause a corresponding undulation of the water-surface whose crests would be five feet above the bottoms of the hollows. This statement is equivalent to saying, that the plumb-line is deviated from its mean direction by the attraction of the mountain chains. Deviations of nearly 30″ have been actually observed near the Alps and near the Caucasus Mountains. The comparatively small deflections observed near the vast mass of the Himalayas in India — which, according to Pratt's calculations in his treatise on attractions, etc., should be vastly greater than any thing actually observed — indicate that extensive portions of the globe under those mountains are less than the average density. Localities have been found in flat countries also, notably in England and Russia, where the deflection of the plumb-line exceeds 15″, which is, of course, due to underlying material of great density. From this it appears, that the true figure of the earth is nearly as diversified as the contours of its hills and valleys, and does not correspond to any known geometrical figure; although, to be sure, these undulations are of small amount. Now, as a first rude approximation, the figure of the earth can be taken as a sphere, having the same volume as the actual earth. The earth at the equatorial regions will then project beyond the figure, and at the poles lie within it.

A second and better approximation can be made by taking the figure to be that of an oblate spheroid; and this is the basis upon which our present geodetic and astronomical measurements are based. Of course, it is possible to find an ellipsoid having three unequal axes which will coincide still more nearly with the results of observations upon the true figure of the earth; and this will furnish a third still closer approximation. This is what has been done by Capt. Clarke in his various publications. A summary of his results is given upon pp. 367 and 368.

It is evident, when the astronomical latitude is determined at any point of the earth's surface by measuring the elevation of the north pole above the horizon, as given by the spirit-level, that that determination will be in error by the entire amount of the local deviation of the plumb-line, which error may be as much as 30″, or more than half a mile, although the observations are made with all possible precision; and the outcome of geodetic triangulation may show that any such station whose position was supposed to have been determined astronomically to single feet really occupies a position, when referred to the spheroid, which at present furnishes the basis of all our astronomical and geodetic work, which is a considerable fraction of a mile from its position as so determined.

The last grand subject treated in the work is that of the tides on the corrected equilibrium theory, and matters closely connected with it. To explain what is meant by this, we shall briefly sketch the rise and progress of the theory of the tides.

Sir Isaac Newton, whose Principia appeared in 1687, showed that universal gravitation would not only account for the motions of the heavenly bodies in their orbits, but would also account for the tides, — phenomena whose cause had not, before his day, been traced to any simple law of nature. He showed that there would be a tide due to the attraction of the sun, and another to that of the moon, the latter being in general the larger; and that the actual tide would depend upon the relative position of those bodies, so that the highest or spring tides would be due to their combined effect, and the lowest or neap tides would occur when the tide due to the sun partially neutralized that of the moon. He showed how other known variations in the tide could be account-

ed for by the declinations of the sun and moon, and their greater or less distance from the earth.

The cause of the tide may be roughly stated, according to the equilibrium theory, thus: the sun or the moon attracts the water on the side of the earth nearer to it more than it does the earth itself, and attracts the earth itself more than the water on the farther side; the consequence being that water is heaped up on the sides of earth away from and toward the attracting body. Or, more exactly, we may imagine

> "The rise and fall of the water at any point of the earth's surface to be produced by making two disturbing bodies (moon and anti-moon, as we may call them for brevity) revolve around the earth's axis once in the lunar twenty-four hours, with the line joining them always inclined to the earth's equator at an angle equal to the moon's declination. If we assume that at each moment the condition of hydrostatic equilibrium is fulfilled, — that is, that the free liquid surface is perpendicular to the resultant force, — we have what is called 'the equilibrium theory of the tides'" (art. 805).

Newton made a modification of this theory, which was intended to take into account the rotation of the earth, by supposing that the full effect of the attraction was not exerted immediately under the attracting body, but that the tide was of the nature of a wave, and by its inertia lagged behind the place where it should have been found in case the earth was not rotating. This retardation he thought might be more than a whole day in some cases. He was not able to submit the whole theory to rigorous computation for lack of sufficient data as to the mass of the moon and the height of the tides; but, from the tidal observations then available, he computed the mass of the moon necessary to produce them according to his theory, and obtained a result which we know to-day to be about twice too large.

In 1738 the French academy proposed the problem of the tides as the subject of a prize-essay, and elicited important essays on the subject from Bernouilli, Maclaurin, and Euler, to each of which was awarded a prize, and in each something of importance was added to Newton's theory; but the foundations of an exact and complete theory were first made in the 'Mécanique céleste' by Laplace, in five volumes, 1799–1825.

The science of mathematical analysis had not been greatly developed at the time Newton wrought upon this subject. His work is expressed in geometrical forms in which his genius is unapproachable. But the new methods of analysis founded upon the calculus, the principles of which were discovered equally by Newton and by Leibnitz, received a rapid and wonderful development during the seventeenth century at the hands of Lagrange and the continental mathematicians. It was to the then existing state of advancement in this particular that the great success of Laplace was due, which enabled him to unravel to so remarkable a degree the intricate interactions of the bodies of the solar system, and give for the first time the fundamental equations of the tides on correct principles. But it must be admitted that Laplace, in integrating his differential equations, seems to have become involved in intricate formulae whose full significance he has not correctly interpreted.

At about the same time, Dr. Thomas Young made an important investigation of the action of the tides, which was published in the Encyclopaedia Britannica, where it has been republished in succeeding editions to the present day. The special point of importance in his investigation was the discussion of the effect of friction upon the tides, which he showed to be such as to explain many difficulties, and that its magnitude might be such as to completely change the character of the tide at certain places so as to make low water take the place of high water, and *vice versa*, — a result hitherto unsuspected, and of prime importance.

The next great step in the theory of the tides was due to Airy, in his article on 'Tides and waves' in the Encyclopaedia metropolitana. He gave in new and concise form a most useful *résumé* of Laplace's theory, and made an original investigation of the effects of friction. He also made valuable additions to the theory as applied to shallow seas and rivers, a subject hitherto untouched.

The labors of Lubbock and of Dr. Whewell have added much to our knowledge of the relations of the theory to the observed tides; but the two foremost cultivators of this branch of science now living are Thomson and Ferrel. The former, who is chairman of the committee appointed by the British association for the advancement of science, for the purpose of the extension, improvement, and harmonic analysis of tidal observations, has done much, by his improved methods of observing tides and discussing them, to separate their components from each other, and render the exact comparison of theory and observed facts possible. Laplace assumed that the fortnightly and semi-annual tides due to the movement of the moon and sun in declination move so slowly that the equilibrium theory applies to them with exactness. But even if that be admitted, it can be shown

that the theory needs correction to take account of the relative amount of land and water, as well as the contour of the continents. These have a controlling influence upon the tides, and this discovery is Thomson's great improvement and correction of the equilibrium theory.

The diurnal tide has been usually explained, in accordance with the equilibrium theory, as a wave existing under nearly static conditions, and following the moon and sun around the earth, but interfered with by friction, and changed in direction by the contour of the land. Though this was the view of Newton, Young, and others, and is incorporated in our ordinary text-books, it is quite inadequate; and the kinetic theory of Laplace must be put in its place, which treats the water as a moving fluid body, subject to the disturbing influence not only of the sun and moon, but of itself also.

The kinetic theory of the tides was to have been developed at length in vol. ii.; and that intended development is more than once referred to by the authors, — as, for instance, on p. 382, where an incidental comparison is made of the results of the two theories.

This part of the theory has been treated by Ferrel in his 'Tidal researches,' published as one of the appendices to the U. S. coast-survey report for 1874, in which work he has put in practical shape all the theoretical work heretofore accomplished, and also deduced therefrom important consequences. Until the publication of this work, it was not possible to apply the correct theory to the discussion and prediction of tides by reason of the unmanageable formulae employed by Laplace; and the discussions were, perforce, made by some modification of the equilibrium theory. Indeed, Laplace himself resorted to that method in his famous discussion of the tidal observations in the harbor of Brest. But, thanks to Ferrel's labors, this most intricate branch of computation has been systematized, and applied to an extensive series of tidal observations in Boston harbor.

The concluding pages, from 422 to 460, treat the question of the rigidity and solidity of the earth as a whole, especially as related to the tides. The final sentence (p. 460) is, "On the whole, we may fairly conclude, that, whilst there is some evidence of a tidal yielding of the earth's mass, that yielding is certainly small, and that the effective rigidity is at least as great as that of steel."

Four important papers on subjects related to those just mentioned are added to the work as appendices. The titles of these papers are, 'Cooling of the earth,' 'Age of the sun's heat,' 'Size of atoms,' 'Tidal friction.' The last three of these were not in the first edition.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

MATHEMATICS.

Fuchsian functions. — A previous paper by M. Poincaré on this subject has already been noticed in these pages (i. **535**). In the present most important memoir, M. Poincaré assumes the results arrived at in the former memoir, and proceeds to more fully develop them and the consequences flowing from them. In the previous paper the author showed that it was possible to form discontinuous groups by substitutions of the form

$$\left(z, \frac{\alpha_i z + \beta_i}{\gamma_i z + \delta_i}\right)$$

by choosing the coefficients $\alpha_i, \beta_i, \gamma_i, \delta_i$, in such a way that the different substitutions of the group should not alter throughout the interior of a certain circle called the fundamental circle. In the present paper the author assumes that the fundamental circle has its centre at the origin, and its radius unity; so that its equation can be written as mod. $z = 1$.

He then considers one of these discontinuous groups, which he calls Fuchsian groups, and which he denotes by G. To this group corresponds a decomposition of the fundamental circle into an infinite number of normal polygons, R, all congruent among themselves. The author then demonstrates that there always exists a system of uniform functions of z, which remain unaltered by the different substitutions of the group G, and which he calls Fuchsian functions. M. Poincaré's memoir is too long to be reviewed here as it deserves. It is certainly a most important addition to the modern theory of functions, and is rendered particularly valuable by the historical note at the end, in which the author gives a brief account of the labors of Hermite, Fuchs, Klein, Schwarz, and others in this field. The two memoirs, with very little amplification, would constitute a really valuable treatise on this subject, — a subject of great importance, and on which there exists absolutely no text-book or treatise of any kind. — (*Acta math.*, i.) T. C. [506

ENGINEERING.

Steam-whistles. —Lloyd and Symes give a statement of experiments with a locomotive whistle having a bell $4\frac{15}{16}$ inches diameter, $3\frac{3}{4}$ inches long inside, and over an annular steam opening $\frac{1}{16}$ of an inch wide. The bell was of cast brass of medium character; and the lip was chamfered to a thin edge, and set exactly over the steam-opening. Sixty pounds press-

ure of steam gave E natural; 80 pounds, F sharp; 90 pounds, G; 110 pounds, A; and 125 to 130 pounds gave C sharp in alt. The distance from steam-opening to edge of whistle was $1\frac{1}{2}$ inches. When it was increased to 2 inches, the power of the sound was sensibly lessened, but the pitch was altered relatively but half a tone. If the distance were decreased to 1 inch, or to $\frac{3}{4}$ of an inch, the whistle would sound only supertones. The notes above were clear, even 'reedy,' and could be heard six miles. A bell of brass tubing, annealed, hammered, and then heated again, gave sounds of somewhat greater intensity and pitch. An iron bell was unsatisfactory. — (*Railr. gaz.*, Aug. 31.) C. E. G. [507

Economy of pumping-engines. — Mr. P. A. Korevaer compares the economy of the scoop-wheel, the Archimedean screw, the pump-wheel, the suction or bucket pump, the double-action pump, and the centrifugal pump, and reports the results to the Dutch institute of engineers. In the Netherlands the pump-wheel is used for lifts less than 2.5 metres (8.3 feet), and the screw for about 4.25 metres (12.5 feet); while the lift and volume delivered by the ordinary forms of pump are unlimited. The economical lift for a centrifugal pump is taken to be as a maximum at about 30 or 40 feet. Its cost in Holland is rather greater than that of a scoop-wheel. The latter gives an efficiency of 64 to 69.5 % on lifts varying from 4 to 6 feet (1.2 to 1.8 metres). The double-acting pump gives an efficiency of 67 to 73 % on lifts between 6.66 and 10 feet (2 to 3 metres). The centrifugal pumps tested gave from 17 to 70 % (averaging 45) in one place, and 40 to 49.3 (averaging 44) in another case. The coal used amounted to from 0.9 to 1.2 kilogr. with scoop-wheels for the drainage of one hectare and a lift of one metre, 1 to 1.17 with double-acting pumps, and 1.56 to 2.19 with centrifugal pumps. The author concludes that a decided gain is obtained by the use of other methods of pumping rather than by the use of the centrifugal pumps,—a conclusion which we may be allowed to agree in, with the qualification that the results would bear a somewhat different complexion if the comparison were with efficient centrifugal pumps, which should be capable of giving an efficiency of at least 66 %. — (*Abs. papers inst. civ. eng.*, 1882–83, iii.) R. H. T. [508

Electric head-light for locomotives. — The Sedlaczek head-light was exhibited at Munich at the late exhibition. It was made by Messrs. Sedlaczek & Wilkulill, as a modification of the lamp of Lacassagne & Thiers, of 1856. The current is supplied by a dynamo placed on the top of the boiler behind the smoke-stack, and driven by an independent engine. The lamp is arranged to turn automatically on curves so as to light the track at all times. The light was visible at a distance of $2\frac{1}{2}$ miles (4 kilometres). The report of the committee intrusted with the observation of the action of the lamp states that the intensity (4,000-candle power) was so great that the guards reported that it dazzled their eyes to such an extent that they were unable to make the observations prescribed by the regulations. The committee express a fear that it may frighten horses. Their apprehensions remind us of the same difficulties as they presented themselves to the opponents of the railway itself. A report made on this lamp in 1881, when used on the Northern railway of France, stated that the experiment proved that the lamp was not extinguished by the jar of the train, and that it did not in any way affect the visibility or the appearance of colors in signals. Engineers of trains were not dazzled by it unless by looking at it persistently, and were not prevented, even then, from seeing the signals. It is proposed to apply the same system of lighting to the cars. — (*Railway rev.*, Oct. 6.) R. H. T. [509

CHEMISTRY.

(Organic.)

Constituents of petroleum from Galicia. — In the oil from this locality Br. Lachowicz has found a normal, and an iso-pentan, two hexans, one heptan, one nonan, and two decans. Other hydrocarbons of this series were present in smaller quantity. No members of the ethylen series were detected. Of the aromatic hydrocarbons, benzol, toluol, isoxylol, and mesitylen were identified. The quantity of 'Wreden's hydrocarbons' — hexahydrobenzol (C_6H_{12}), hexahydrotoluol (C_7H_{14}), and hexahydro-isoxylol — in the Galicia petroleum lies between that of the Caucasus and the American oils. — (*Ann. chem.*, 220, 168.) C. F. M. [510

Compounds of the indigo group. — In the course of his investigations upon the constitution of indigo, A. Baeyer has tried several reactions to determine the position of the hydrogen atom which is not in the benzol ring. If the formula

$$\begin{array}{l} C_6H_4 - CO \\ \;\;| \qquad\; | \\ N = COH \end{array}$$

is assigned to isatin, the isomeric form called by Baeyer pseudo-isatin would have the form

$$\begin{array}{l} C_6H_4 - CO \\ \;\;| \qquad\; | \\ HN - CO \end{array} ;$$

and the form of pseudo-indoxyl isomeric with indoxyl,

$$\begin{array}{l} C_6H_4 - COH \\ \;\;| \qquad\; \| \\ HN - CH \end{array} ,$$

would be

$$\begin{array}{l} C_6H_4 - CO \\ \;\;| \qquad\; | \\ HN - CH_2 \end{array} .$$

Baeyer draws the following conclusions from his results concerning the structure of indigo: —

1. It contains an imido group.
2. The carbon atoms have the arrangement

$$C_6H_5 - C - C - C - C - C_6H_5.$$

3. It is formed only from compounds in which the carbon atom next to the benzol ring has attached to it an oxygen atom.
4. In its formation and properties it is closely related to indirubin and the 'indogenides' of ethyl-pseudo-isatin.
5. The latter results from a union of the α-carbon atom of pseudo-indoxyl with the β-carbon atom of pseudo-isatin.

The formation of indigo may therefore be shown by the equation —

$$\begin{array}{ccccc} \begin{array}{l} C_6H_4 - CO \\ \;\;| \qquad\;\; | \\ HN - CH_2 \end{array} & + & \begin{array}{l} CO - C_6H_4 \\ | \qquad\quad | \\ CO - NH \end{array} & = & \begin{array}{l} C_6H_4 - CO \qquad CO - C_6H_4 \\ \quad | \qquad\quad | \qquad\quad | \qquad\quad | \\ HN \qquad C = C \quad - NH \end{array} + H_2O. \\ \text{Pseudo-indoxyl.} & & \text{Pseudo-isatin.} & & \text{Indigo.} \end{array}$$

— (*Berichte deutsch. chem. gesellsch.*, xvi. 2188.) C. F. M. [511

AGRICULTURE.

Maintenance of fattened animals. — Kellner having observed that simple maintenance-fodder was sufficient to prevent fatted sheep from losing weight, Vossler has tried the same proceeding with sheep and oxen, and confirmed Kellner's observation. — (*Biedermann's centr.-blatt.*, xii. 612.) H. P. A. [512

Relation of manure to quantity of seed. — In experiments on the drill-culture of barley, Märcker finds, that, as the distance between the drills is increased, the yield decreases, unless more nitrogenous fertilizer is applied. — (*Ibid.*, xii. 620.) H. P. A. [513

Seed-potatoes. — In an experiment with potatoes at the New-York agricultural experiment-station, single eyes gave better yields in proportion as they were located near the terminal portion (seed-end) of the tuber. — (*N. Y. agric. exp. stat., bull.* lxiv.) H. P. A. [514

Potato-culture. — Previous experiments having led to the hypothesis that the most favorable conditions for the growth of potatoes are coolness and moisture for the roots, and warmth and dryness for the tubers, an attempt was made to test the hypothesis by planting potatoes on ridges, and mulching the intervals. The season, however, was very wet, so that the desired conditions for the tubers were not attained. As it was, the parallel plots under ordinary culture gave decidedly greater yields. — (*Ibid.*, lxv.) H. P. A. [515

Fertilizers for tobacco. — Nessler has repeated part of his well-known experiments on the effect of various salts upon the quality of tobacco. The present experiments consisted of a comparison of the chloride, sulphate, and nitrate of potassium in this respect, as well as of a few other fertilizers. The results were essentially the same as those previously reached: the sulphate and nitrate improved the burning qualities, while the chloride, except in one case, caused them to deteriorate. The chloride also increased the percentage of chlorine in the ash. The author recommends applying phosphatic and potassic fertilizers to the preceding crop, and only nitrogenous fertilizers directly to the tobacco. — (*Landw. vers. stat.*, xxix. 309.) H. P. A. [516

Glutamin in beet-juice. — In an earlier investigation, Schulze and Urich obtained glutaminic acid and ammonia by boiling beet-juice with hydrochloric acid, and from this fact concluded that the juice contained glutamin, a substance which had then never been prepared. Schulze and Bosshard have now succeeded in preparing glutamin from beet-juice. The juice is first treated with lead acetate. The filtrate from this precipitate is treated with mercuric nitrate, and the resulting precipitate decomposed by means of hydrogen sulphide.

Glutamin crystallizes from aqueous solution in fine, white, anhydrous needles, soluble in hot water and dilute alcohol. It is readily decomposed by acids or alkalies into glutaminic acid and ammonia, the decomposition taking place gradually, even in the cold or on simple boiling with water. Consequently ammonia cannot be determined in vegetable extracts containing glutamin, either by Schlösing's method or by boiling with magnesia. — (*Ibid.*, xxix. 295.) H. P. A. [517

GEOLOGY.

Correlation of Cambrian rocks. — Mr. Charles D. Walcott, of the U. S. geological survey, has recently reviewed the great Cambrian sections of North America. He defines the Cambrian as the formation characterized by the 'first fauna' of Barrande.

In New York, on one side of Lake Champlain, near Chazy, the formation is constituted by the Potsdam and calciferous; and the biologic transition to the Silurian, as represented by the Chazy, is abrupt. In Nevada there is a gradual passage from the Potsdam fauna to the Silurian; and beneath the Potsdam are rocks containing the Olenellus fauna. In northern Arizona the section exhibited by the Grand Cañon of the Colorado shows at bottom the Grand Cañon and Chu-ár groups, which contain barely fossils enough to characterize them as early Cambrian. These were greatly eroded before the deposition of the Tonto with a profuse fauna equivalent to that of the Potsdam. The Silurian is absent, and the Devonian rests on the Tonto. In Wisconsin the Potsdam is underlain unconformably by the faunaless Keweenawan, and overlain conformably by the Silurian. In Vermont the Potsdam rests on the Georgian group containing the Olenellus fauna. In Tennessee the upper Cambrian is represented by the Knox shale, and the lower by the Chilhowee sandstone and the Ocoee conglomerate. In New Brunswick the St. John's group, and in Massachusetts the Braintree argillites, exhibit the Paradoxides fauna. At the Straits of Belle Isle the section is not continuous, but appears comparable with that of Nevada. The anomalous relations reported at Point Levis, in Canada, are attributed to error in the interpretation of the stratigraphy.

The Tonto group of Arizona and the Knox group of Tennessee are recognized by Mr. Walcott as the equivalents of the Potsdam of New York, Vermont, and Wisconsin. The Olenellus horizon of Nevada is correlated with the Georgian group of Vermont. The Grand Cañon and Chuar groups of Arizona are provisionally correlated with the Keweenawan of Wisconsin, and are regarded as older than the Georgian. The St. John's group of New Brunswick is held to be older than the Georgian, and probably younger than the Keweenawan and Chuar. The Chilhowee and Ocoee groups of Tennessee are provisionally assigned to the horizons of the Georgian and St. John's.

The paper marshals the stratigraphic evidence only, leaving the paleontologic to form the subject of a future communication. — (*Phil. soc. Washington; meeting* Nov. 24, 1883.) [518

PHYSICAL GEOGRAPHY.

Influence of climate on vegetation in Alaska. — In his remarks on glaciers in Alaska, Mr. Thomas Meehan remarked, that, on the top of what are known as 'totem-poles' in some of the Indian villages, trees of very large size would often be seen growing. These poles are thick logs of hemlock or spruce, set up before the doors of Indian lodges, carved all over with queer characters representing living creatures of every description. These inscriptions are supposed to be genealogies, or to tell of some famous event in the family history. The poles are not erected by Indians now, and it is difficult to get any connected accounts of what they really tell. At a very old Indian village, called Kaigan, there are a large number of these poles, with few, or, in some cases, no carvings on them, among many which are wholly covered; and these all had one or more trees of Abies sitkensis growing on them. One tree must have been about twenty years old, and was half as tall as the pole on which it was growing. The pole may have been twenty feet high. The roots of the tree had descended the whole length of the poles, and had gone into the ground from which the larger trees now derived nourishment. In one case the root had grown so large as to split the thick pole on one side from the top to the bottom; and this root projected along the whole length, about two inches beyond the outer circumference of the pole. Only in an atmosphere surcharged with moisture could a seed sprout on the top of a pole twenty feet from the ground, and continue for years to grow almost or quite as well as if it were surrounded by soil. He had seen a bush of Lanicera involucrata which was of immense size as compared with what he had seen in Colorado and elsewhere. The plant was at the back of an Indian lodge, and beside a pathway, cut against the hillside. The stems near the ground were as thick as his arm, and the whole plant was covered with very large blackberries. Stopping in admiration to look at and admire the specimen brought numbers of Indians to see what was the subject; and these smiled indulgently on being made to understand that only the sight of a huge bush had attracted the travellers' attention. — (*Acad. nat. sc. Philad.; meeting* Nov. 6.) [519

BOTANY.

(*Fossil.*)

Australian coal flora. — A memoir prepared with great care by Rev. J. E. Tenison-Woods is valuable to science, not only for the clear and detailed description of the fossil plants, but for the discussion upon the geological distribution of the coal-bearing measures of Australia.

The first notice in regard to the Australian fossil flora was given by Prof. Morris in 1845. In 1847 McCoy gave an elaborate paper on the flora and fauna of the rocks associated with the coal of Australia, and came to the conclusion that a wide geological interval probably occurred between the consolidation of the fossiliferous beds underlying the coal, and the deposits of the coal-measures, as he found no real connection between them, and as they were referable to widely different geological systems.

In 1848 Rev. Mr. Clarke dissented from the above conclusions, maintaining that there is no break whatever between the various beds containing the remains of plants described. His assertion was based upon his own discoveries, and the researches of Jukes and Dana.

After recording the long discussion between McCoy and Clarke, the progress made on the subject by Daintree, Feistmantel, etc., the author gives a clear exposition of the Australian coal-formations, as far as they are known at the present time, considering not only the remains of plants and animals found in connection with the strata, but the composition of the measures, and the localities where the strata have been examined. He gives the formations in the following series: —

1. Upper Devonian, with three species of plants.
2. Lower carboniferous, six species, among them three of Lepidodendron.
3. Permian (?), five species, among them two of Glossopteris.
4. Newer coal, trias (?) (Newcastle), fourteen species; of these, seven of Glossopteris, of which Glossopteris Browniana is most common, and also found in No. 3.
5. Rhaetic.
6. Upper lias (?), with two species.
7. Jurassic, with twenty-two species.

In recording the plants and their distribution, the author describes ninety-three species: twenty-seven are new. The plates are photographs of specimens. The remains of plants are very indistinctly and insufficiently represented. — (*Proc. Linn. soc. N. S. Wales*, viii. 37.) L. L. [520

ZOÖLOGY.

Reconstruction of objects from microscopic sections. — Born gives an elaborate description of his method of modelling, which is really very simple as well as ingenious. The sections are made with great care, all of the same thickness: they are next drawn with the camera, and the outlines transferred to wax plates, the thickness of which is chosen so as to correspond in relation to the thickness of the sections, as do the outlines to the superficial dimensions of the sections; or, in other words, each wax plate is cut out so as to represent the actual section equally magnified in all three dimensions. — (*Arch. mikrosk. anat.*, xxii. 584.) C. S. M. [521

Preservation of soft tissues. — Dr. Benjamin Sharp called attention to Prof. Semper's mode of preparing dried specimens of soft animals, and exhibited a couple of snails as illustrations of the admirable results of the process. The tissues are first hardened by being steeped in chromic acid, which is afterwards thoroughly washed out in water. The speci-

men is then allowed to remain in absolute alcohol until the water is perfectly extracted, when it is placed in turpentine for three or four days. It may then be dried and mounted. Specimens prepared in this way retain their characters in a very satisfactory degree, and are strong and flexible, the examples shown resembling kid. If the surface be treated, after drying, with a solution of sugar and glycerine, the natural colors will be restored; but the specimens must then be kept in hermetically sealed glass cases to preserve them from the dust. The objection to this mode of treating large specimens is the expense of the absolute alcohol: otherwise there is no reason why the largest animals should not be preserved by this process. — (*Acad. nat. sc. Philad.; meeting* Nov. 21, 1883.) [522

Preservation of protozoa and small larvae. — Hermann Fol recommends an alcoholic solution of ferric perchloride to kill small animals without injury to the tissues. It is diluted with water down to two per cent, and then poured into the vessel holding the animals. These then sink to the bottom. The water is poured off, and seventy per cent alcohol substituted. Change the alcohol, and add to the second dose of it a few drops of sulphuric acid: otherwise the iron may remain in the tissues, and cause them to overstain with coloring-reagents. The alcoholic washing should be thorough. Even larger animals (medusae, Doliolum, etc.) may be perfectly preserved by this method. The tissues may be subsequently stained by adding a few drops of gallic acid (one-per-cent solution) to the alcohol containing the specimens. The nuclei are stained dark, the protoplasm light brown, in twenty-four hours.

Fol also describes some new injection masses, which offer the advantage that they may be readily kept without spoiling. — (*Zeitschr. wiss. zool.*, xxxviii. 491.) C. S. M. [523

Fossils of Pachino. — The Marquis de Gregorio has published a brochure of twenty-five pages on the fossils of this locality. They comprise cretaceous forms of the horizon of Hippurites cornucopiae, and tertiary species of the horizon of Carcharodon megalodon Ag. The work is in octavo, and illustrated by six excellent phototypic plates representing corals, echinoderms, and a few mollusks. Simpulorbites, a new genus of Foraminifera allied to Orbitolites; Escharopsia, a new genus of Polyzoa; and Proteobulla, a form represented by casts, recalling Buccinulus, but with three strong horizontal plaits on the column, — are described and figured. — W. H. D. [524

Mollusks.

Spicula amoris of British Helices. — Charles Ashford contributes an interesting and comprehensive paper on the 'darts' found in connection with the reproductive apparatus in certain Helices. The dart is contained in a short ventricose pouch opening into the lower part of the vaginal tube, a little above the common vestibule, on the right side of the neck. There is usually one: if two are present, the second sac is on the opposite side of the tube from the first. The sac may be simple, or bilobate. At the bottom of the cavity of the sac is a conical papilla, which serves as a basis for the dart, which is attached to it by its posterior end. The apparatus is a development of adult life, and especially of pairing-time, but is indifferently present or wanting in species otherwise closely allied. The dart itself is a tubular shaft of carbonate of lime, tapering to a solid, transparent, sharp point, enlarging at or toward the base, where it assumes the form of a subconical cup. The sides of the shaft are sometimes furnished with blade-like longitudinal buttresses, which serve to strengthen it. They are rapidly formed, may be secreted in six days, and differ in form in different species. They are supposed to serve the purpose of inducing, by puncture, the excitement preparatory to pairing. They are too fragile to do more than prick the tough skin of these mollusks, but sometimes penetrate the apertures of the body, and are found within. A new weapon is formed after the loss of the old one. It is best extracted for study by boiling the sac in caustic potash. — (*Journ. conch.*, July, 1883.) W. H. D. [525

Shell-structure of Chonetes. — John Young, in the course of an examination of C. Laguessiana Kon., finds on the ribs a series of wide-set tubular openings, perhaps bases of spines, which do not extend to the interior of the shell; also a row of very minute close-set pores, placed along the central line of each rib, but which disappear after descending a very short distance into the shell-substance; a series of raised tubercles, which appear on the interior surface of the valves arranged between each pair of ribs in single rows, and which send rather distant tubules obliquely outward and backward as far as the middle layer of the shell; lastly, in the thickened cardinal edge of the ventral valve, corresponding to the spines with which it is ornamented, a series of tubes which open with round orifices on the interior, and which converge toward a point near the apex of the beak, but at the surface are continuous with the hollow of the tubular spines which point away from the beak in a direction nearly at right angles with their previous course. In a note on this communication, Mr. Thomas Davidson mentions that in Chonetes plebeia, tenuicostata, sarcinulata, and the Devonian C. armata, Mr. Young finds no trace of the external perforations described above in C. Laguessiana, although small perforations or tubules extended nearly to the middle shell-layer from the interior of the valves, slanting toward the beaks. In Productus (with a doubtful exception in the case of P. mesolobus), also, Mr. Young finds the perforations extending only part way from the interior, and never visible on the unabraded external surface of the shell. The same fact has been determined by him for the genera Strophomena and Streptorhynchus. — (*Geol. mag.*, Aug., 1883.) W. H. D. [526

VERTEBRATES.

Mammals.

Aortic insufficiency and arterial pressure. — Both Rosenbach and Cohnheim have stated that sudden insufficiency of the aortic valves, produced artificially, has no effect on arterial pressure. Goddard,

on the other hand, from experiments made upon rabbits, says, that after perforation of the aortic valves, there is an important fall of pressure. De Jager has repeated these experiments, using both dogs and rabbits. Upon dogs he finds that perforation of the valves has little or no effect on arterial pressure; whereas, with rabbits, a considerable and permanent fall of pressure is the result. It appears from these experiments that the compensatory power of the heart-muscle is greater in the dog than in the rabbit, although de Jager thinks that the results may be partly explained by the fact that the injury to the valves in the case of the rabbits was generally more extensive than in the case of the dogs. — (*Pflüger's archiv*, xxxi. 215.) W. H. H. [527

Structure of the placenta. — Ercolani has renewed the advocacy of his views on the mammalian placenta, according to which, after conception, the mucosa of the uterus falls off, and a new cellular decidual layer is formed, and after delivery the mucosa is re-formed. ports some new observations, particularly on the dormouse and on woman, by which he endeavors to strengthen his position. He writes in the form of letters addressed to Prof. Kölliker at Würzburg. Dr. H. O. Marcy, in the *New York medical journal* (July 28 - Aug. 4), gives an account of these letters, but adds nothing original. The difficulty as to Ercolani's views is threefold: he leaves in obscurity the exact histolytical and histogenetical changes in, 1°, the assumed shedding of the mucosa; 2°, the appearance of the new-formed decidua; 3°, the regeneration of the mucosa. For the present, Kölliker's view, that the maternal decidua is the metamorphosed mucosa, has at least an equal claim for acceptance with Ercolani's theory. — (*Rendic. accad. sc. ist. Bologna*, Jan. 28, 1883.) C. S. M. [528

Touch-corpuscles and other nerve-endings in man and apes. — W. Wolff has investigated the corpuscles of touch in Cercopithecus, the chimpanzee, and man. The corpuscles are essentially the same in all. They have an oval form, and are distinguished by having the connective-tissue envelope thrown into folds parallel with their long axis, the folds being delicate and close together. The content of the capsule is a granular, coherent fluid. According to Wolff, the supposed nerve-filaments seen in gold preparations are really precipitates formed in the folds of the capsule.

The author questions whether the nerves have any terminations in epithelium. His principal objection is, that, if the cornea of small animals is macerated for several hours in weak gold solutions, the epithelium falls off as a distinct membrane. Now, as gold fixes the nerves, if any filaments ran to the membrane, they would hold it down, and the epithelium would not separate. The author confuses fixing the optical form of the nerves and fixing their coherency. There is no reason against, but, on the contrary, many reasons for, assuming a maceration of the nerve-filaments in weak solutions of gold. In view of the very numerous positive observations of nerve-endings in epithelia, Wolff's argumentation is weak, and it appears unnecessary to follow his further deductions; viz., that since glands are modified epithelia, and epithelia have no nerve-endings proper, therefore the gland-cells have no nerve-endings. Such attempts to set aside a vast body of evidence on account of a few imperfect observations ought not to be countenanced. — (*Arch. anat. physiol., anat. abth.*, 1883, 128.) C. S. M. [529

The action of digitaline on the heart and blood-vessels. — The authors of this paper, Donaldson and Stevens, have made a careful and thorough study of the action of digitaline on the heart and blood-vessels, and have arrived at results differing from those usually accepted. The evidence obtained by previous investigators is summarized by them as follows: "Investigations on the frog's heart show an increase of work; investigations on the arterioles have led to contradictory results, with the weight of evidence in favor of a constriction." In their own work they made use of frogs and terrapins. The heart was completely isolated from the rest of the body, and kept alive by defibrinated blood supplied to it from the venous side; while the outflow of blood from the ventricles, in the method used, could easily be determined at any time, and the relative amount of work done by the heart, when pure blood or blood containing digitaline was fed to it, estimated. The conditions under which the heart worked were made, as far as possible, the same as those existing during life. The result of these experiments was that digitaline causes a decrease in the work done by the heart. On the other hand, digitaline injected into the living animal in moderate doses increases the blood-pressure. This increase of blood-pressure cannot be caused by the heart: it must result, therefore, from a constriction of the arterioles. Experiments were made in which the arterial system was supplied with normal salt solution at a constant pressure, and the outflow collected from the large veins emptying into the heart. The heart was thus excluded from the problem. It was then found, that, when digitaline was added to the circulating liquid, there was a diminution in the outflow from the veins; and this diminution could only be caused by a constriction of the arterioles. The result of their work, then, is that digitaline causes a decrease in the work done by the heart, but increases mean blood-pressure by constricting the arterioles. — (*Journ. of physiol.*, iv. 165.) W. H. H. [530

(*Man.*)

Cilia in the human kidney. — That a large portion of the renal tubules in cold-blooded vertebrates is ciliated has been known for some time. It has also been known, from the observations of Bowman and others, that the neck of the Malpighian capsule in mammals is ciliated. A. H. Tuttle found, from the examination of a large number of sections of human kidneys, that the convoluted tubule is very extensively, if not generally, ciliated. Where the flat lining-cells of the capsule approach the neck, they become cuboidal and ciliated also. The cilia in the kidney are from 3.5 to 5 μ long, very fine, numerous, and closely set. Confirmatory observations were made on the kidney of a kitten. The cilia are probably pres-

ent in all mammalia, and serve to propel the urine outwards or towards the ureter. — (*Stud. biol. lab. Johns Hopk. univ.*, ii. 453.) C. S. M. [531

ANTHROPOLOGY.

Man's place in nature. — One hears now and then the assertion that man is not the highest animal. In proof of this assertion, it is urged that this animal is far more specialized in one direction, and that animal in another. Mr. Lockington takes the ground that specialization is not in itself any proof of advance. Now, the real progress is not to be sought in the specialized offshoots of any series, but in the growing stem from which it is parted. The highest specialization is that based upon perfection of the greatest number of parts, not upon the great development of one part at the expense of others. "We need not ask morphologists or embryologists whether man is the highest animal: we have the proof of it every hour before our eyes. His powers of mind are the resultant of his structure, and have enabled him to conquer all other beings in the struggle of life. That animal is highest which possesses the widest range of faculties. This man undoubtedly does. No other animal has the power, by voice or pen, to exaggerate or depreciate its own importance; no other animal can use the powers of nature as he; no other can produce works which are proportionately comparable to his: and if, therefore, morphology or embryology contradict the facts of life, then are those sciences unsafe guides, as they certainly are only partial ones." — (*Amer. naturalist*, Oct.) J. W. P. [532

Notation of kinship. — In the study of kinship many schemes of graphic representation have been devised. A perfect system should exhibit three ideas: It should, 1. Identify each place in the series; 2. Classify kindred for each people; 3. Exhibit affinity or marriage, as well as kinship. Mr. Francis Galton presents us with a new scheme, identifying the members of the series and sex, in which arithmetical notation takes the place of letters or pictographs. — (*Nature*, Sept. 6.) J. W. P. [533

Curare. — M. Couty has made extended observations and experiments on the curare poison, and has given the benefit of his studies in a course of lectures in the museum of Rio Janeiro. The investigation closes with a modest confession of ignorance. "The *curare*," says M. Couty, "demands fresh physiological studies to comprehend the nature of its relation to the muscles and the nerves, and also the real significance of the various phenomena of excitement and paralysis which it occasions, before we should attempt to comprehend the intimate mechanism of its intoxicating influence." — (*Rev. scient.*, 1882, 587, etc.) J. W. P. [534

Color-words in the Rig Veda. — Geiger wrote, 'The men of that time [of the Rig Veda] did not and could not call any thing blue.' Mr. Edward W. Hopkins reviews the deductions of Geiger, and not only questions the facts adduced by him, but also doubts whether his application of the statements be admissible, even if proved to be facts. The use of color-words is not unlike that in other poetic literatures. Mr. Hopkins concludes: 1°. Non-mention of the colors green and blue is not proved for the Rig Veda literature; 2°. That the sky is not called blue, nor the fields green, rests on reasons which have nothing to do with the development of the retina; 3°. We cannot admit that either color-words or color-perception of those who composed the Rig Veda were inexact or imperfect; for the cause of the apparently inexact employment of words lies in the variable and uncertain color of the objects to which the color-terms are applied.

If the Vedic literature fail to support the theory of the late development of the color-sense, one of the strongest of the negative proofs is withdrawn; and even the absence of certain colors in Homer may be deemed, perhaps, of less significance than has been claimed when we consider that the Niebelungenlied exhibits, twenty centuries later, the same absence of corresponding colors, and a like ratio in the greater use of terms denoting red and yellow. — (*Amer. journ. phil.*, iv. 166.) J. W. P. [535

The Yuma linguistic stock. — In the year 1877 Mr. A. S. Gatschet brought together in two papers all that was then known with reference to the Yuma stock of languages spoken around the mouth of the Colorado of the west. Recently he has come into possession, through the Bureau of ethnology and private correspondence, of new and important material, and has been compelled to publish an appendix to his former papers. This consists of information respecting the names and characteristics of the tribes belonging to this stem; comparative vocabularies of the Yavapai, Ni Mai, and the Seri; the Yavapai vocabulary of Dr. W. H Corbusier; and the Tonto vocabulary of Dr. John B. White. — (*Zeitschr. ethnol.*, xv. 123.) J. W. P. [536

The tempering of bronze. — No doubt, native copper attracted the attention of primitive man before any of its alloys; but the difficulty of working it for a long time prevented its general use. How the metal came to be associated with tin in various forms is entirely unknown to us. Arms and implements of bronze in Egypt, Greece, and Gaul, present a constant proportion of tin, — twelve per cent. The bronze of cannons is eight to eleven per cent; of bells, twenty to thirty per cent. Recently, at Réalon (Hautes-Alpes), a peddler's pack of bronze objects has been unearthed, showing eighteen per cent of tin.

The founders of prehistoric times seem to have had three methods of procedure: —

1°. The alloy was poured into a mould of stone or metal in two pieces. The ridge formed by the junction was afterwards hammered down.

2°. A model of wood was pressed upon a layer of sand in a box, to obtain a negative of one side: a corresponding operation gave a mould of the other side. The two boxes fitted together completed the mould. There were still seams requiring to be hammered.

3°. A model of wax was surrounded with soft clay. The clay was then heated to harden it and to melt

the wax. The metal was introduced at the opening left for the escape of the wax.

Soldering was unknown to the men of the bronze age: mending was done by riveting. The art of softening bronze was known to the ancients. Proclus says (Works and Days, line 1842) that "in ancient times men used bronze in cultivating the ground just as they use iron now; but that copper being soft in its nature, they hardened it by immersion." Eustathius also says (Iliad, book I., line 236) that they tempered the bronze when using it in place of iron. The chemist Darcet, at the end of the last century, showed: 1. That pure copper, heated to redness and plunged into cold water, is neither hardened nor softened; 2. Bronzes having only tin alloy, and that less than thirty per cent, heated and cooled in air, become weak and brittle; 3. The same bronzes, heated and cooled in water, are softened, and become very tractable.

It is nearly certain that the men of the bronze age tempered their implements in taking them from the mould. Those destined to stand a blow were left in this state. Arms and tools needing more temper were heated over, and cooled in the air.

Another prehistoric art, rediscovered by the engineers of Alexandria, and recently again brought to light from the orient, is rendering bronze flexible. This property of flexibility is certainly possessed by some very ancient specimens. The engineer Philo, who lived in the century before our era, describes, in his 'Treatise on artillery,' the fabrication of springs of bronze needed in some of his machinery.

The author from whom the foregoing notes are taken, A. de Rochas, will soon publish, through Masson at Paris, a volume on the origin of industry, and the first application of the sciences. — (*Rev. scient.*, Sept. 22.) J. W. P. [537

Seamy side of the Vedas. — Max Müller tells us in his recent work, 'India, what it can teach us,' that in the Vedas we have a nearer approach to a beginning, and an intelligible beginning, than in the wild invocations of Hottentots and Bushmen. Mr. Andrew Lang holds the mirror up to this assertion by showing that a highly civilized people are farther from the beginning in their religion than races which have not evolved nor accepted society. Again: there is nothing particularly wild in some of the invocations of the Bushmen (*Cape monthly*, July, 1874), nor of the Papuans (*Journ. anthrop. inst.*, Feb., 1881). Compare the prayer of Odysseus to the Phaeacian king. And, finally, the faith of Vedic worshippers was very near akin, in the wildness of its details and its mythology, to the faith of Bushmen and Hottentots. In the Rig Veda human sacrifice has left its traces, the practice enduring in symbols and substitutes which point back to something 'nearer the beginning.' The ninetieth hymn of the tenth book of the Rig Veda tells how all things were made out of the limbs of a giant, Purusha. A similar legend is found among Scandinavians, Iroquois, Egyptians, Greeks, and Tinneh. It would be easy to show that Vishnu, in the shape of a boar bringing up the world from the waters, is equivalent to the North American coyotes and muskrats performing the same feat. The origin of species from Purusha is matched only by the metamorphoses and amatory pursuits of Zeus, Kronos, Demeter, and Nemesis. Indeed, we seem to have a nearer approach to a beginning in the Vedic hymns, in those very portions in which they resemble the primitive philosophy of Bushmen and Navajos. The gods in the Vedic religion are deified nature; and we frequently see gods in animal form fighting with animals, afraid of enemies, behaving like the half anthropomorphic, half theriomorphic deities of the Australians, Hottentots, and Bushmen. The gods are begotten of heaven and earth, and are not necessarily immortal. The birth of Indra is very similar to that of Heitsi-Eibib, the supreme god of the Hottentots; and some of his feats have parallels in Scandinavian, Thlinkit, Murri, and Californian myths. Speaking of the other Vedic gods, Mr. Lang quotes the language of Racine respecting the deities of the Greeks: "Burning was too good for most of them. . . . If any one wishes to see at a glance how much savage thought persisted till the age of the Brahmanas, let him compare the myths of the constellations (*Sacr. books of the east*, xii. 282) with the similar myths in Brough Smyth's 'Aborigines of Victoria.' Except upon the hypothesis that the Aryans came civilized into the world, they must have descended from savage ancestors. That they retained savage practices, such as human sacrifices, and much worse things, is universally admitted. Why should they not have retained savage ideas in religion and mythology, especially as of savage ideas Aryan mythology and religion are full to the brim?" — J. W. P. [538

Anthropology at Berlin. — The organ of the Berlin society of anthropology has just completed its fifteenth year, and contains matter of interest not only to the local but also to the general student. Part iv. opens with a paper by Ernst Bötticher on the analogies of the Hissarlik finds. Dr. Schliemann's 'owl-faced' vases are characterized as *canopus* vases, and thus connected in type with the various art productions of Egypt, in which the bird-face predominates. The ornamentation of funereal urns with a bird-face, — be it that of a falcon, owl, or sparrow, — and the occurrence of the same custom from the Baltic to the Nile banks, are worthy of remark. Until historic evidence clears up the subject, the learned must move their opinions back and forward in the alternation of independent evolution and social contact. —— Prof. Arzruni reviews the jadeite and nephrite discussion, quoting and criticising the writings of Meyer, Damour, Janettaz and Michel, Fischer, Beck, and v. Muschketow. The author carefully excludes from the discussion minerals which have been confounded with those above named, and also mentions the fact that they have different characteristics in different localities. In Europe, up to this time, neither jadeite nor nephrite has been found *in situ*. Prof. Arzruni closes his paper with the citation of those localities in each continent which have furnished the minerals or their products. —— M. Kulischer speaks of the handling of children and

youth upon the lower culture steps. He broaches a very ingenious theory, which seeks to include infanticide and all sorts of torture and ordeals in a common category of helping the survival of the fittest. In savagery, intimates the author, two children are as many as the parents can raise: they knock the surplus on the head. They subject their sons and daughters to frequent vigils, fastings, fatigues, and pains, mourning for them meanwhile as dead. Indeed, many die under the treatment, but the fittest survive. Very many scraps of information, gathered here and there, are brought within the range of the author's theory. In this connection, one should not fail to consult Ploss: 'Das kind in brauch und sitte der völker.' —— Mr. Aurelius Krause read a paper upon the relationships existing among the peoples of the Chukchi peninsula. Are the coast Chukchi and the reindeer Chukchi the same people? —— In speaking of the 'footsteps of Buda,' — a gigantic track found in the ruins of the most hallowed shrine of Buddhism at Gaya, in southern Bihar, — M. Grünwedel calls to mind, that in every part of the world are to be found, in solid rock, impressions made by the feet of gods and heroes. —— Gen. von Erckert sends to the society from Petroosk measurements of the weight, length of body, and length of limbs, taken from Russian peoples, — Wotjaks, Great Russians, Little Russians, Volga Tartars, Meshtsheraks, Poles, Bashkirs, Tscheremis, and Jews. — (*Zeitschr. f. ethnol.*, xv. pt. 4.) J. W. P. [539

The London anthropological institute. — The unlimited resources of British anthropologists lead one always to expect something good from the journal of the institute. The first paper in the current number is by F. Bonney, on some customs of the aborigines of the River Darling, New South Wales. Mr. Bonney resided on a sheep-range from 1865 to 1880, and therefore knew the Bungyarlee and Parkungi tribes 'before they were spoilt by civilization.' The aboriginal population, owing to periodic droughts of great severity, could never have exceeded 100 on an area of 2,000 □ m. Epidemics also have told upon the people. There is a typical similarity among all Australian aborigines; but, to a close observer, each tribe has its own peculiarities. The oft-repeated statement that they are the lowest type of humanity is a libel. Mr. Bonney describes their parturition customs, systematic infanticide, child-rearing, initiation of youth, class-marriage, courtesy, charms, sucking-cure, diseases, blood-cure, burials, and mourning. —— Mr. Tremlett writes of stone circles in Brittany, by which is meant two concentric rings of rude stone masonry, covered by a mound. One, called Nignol, was undoubtedly a cremation mound; since, exterior to the outer circle, cinerary urns were found, as well as between the walls. The inner circle consisted almost entirely of ashes and charcoal. Two others were similarly constructed, — one at Coët-a-touse, the other at Kerbascat. —— The subject of group-marriage is reviewed by Mr. C. S. Wake, and an attempt made to show its origin. The author assumes two fundamental rights, — the individual, or sexual; and the tribal, or self-protective. The origin of the Australian four-class division is to be sought in the separation of the original marrying group into two grades, a parent and a child grade. —— Major H. W. Fielden exhibited a series of South African stone implements. —— The Rev. James Sibree, following up the investigations of Col. Garrick Mallery, U.S.A., reports a number of gestures from Madagascar as a contribution to the study of comparative sign-language. —— Mr. A. W. Howitt reports some Australian beliefs, commencing with a delightful paragraph or two on synonymy, which we should like to quote. The superstitions described relate to the physical universe, the human individual here and hereafter, and Ghost-land. —— On the 19th of June a special meeting was held at the Piccadilly hall, by invitation of Mr. C. Ribeiro, who exhibited five Botocudo Indians and a collection of implements. —— Mr. A. H. Keane read a paper on the Botocudos. Their home is the province of Espiritu Santu, in Brazil; their name, probably from the Portuguese *botoque* (a barrel-plug), alluding to their labrets. The Tembeitera, or lip ornament, and the immense ear-plugs, give rise to an extended notice of the geographical distribution of these objects. The Botocudos are of Guarani stock physically, although of non-Guarani speech. Their physical characteristics are elaborately set forth by Mr. Keane, and extended references made to their culture, sexual relations, dwellings, industries, tribal organization, burials, religion, and language. — (*Journ. anthrop. inst.*, xiii. no. ii.) J. W. P. [540

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

GOVERNMENT ORGANIZATIONS.

Geological survey.

Geology. — Mr. J. S. Diller, an assistant of Capt. C. E. Dutton, who has charge of the investigation of the volcanic rocks in the division of the Pacific, made a geological reconnaissance of the Cascade Range, during the early part of the season, in exploring the eastern side of the range; going as far north as the Dalles, and thence to Portland, finally coming down on the west side to Red Bluff, California. He and his party travelled some twenty-five hundred miles. They were unable to do any topographical work on account of the smoke, which also interfered with the work of Mr. Gilbert Thompson (chief topographer of the California division) in the neighborhood of Mount Shasta.

Paleontology. — During the past season Mr. Charles D. Walcott received at the office, for the use of the National museum collections, a series of

typical specimens, representing seventy-eight species described by Mr. U. P. James, from the Hudson River group in southern Ohio. These are the gift of Mr. James, and have been recorded. Mr. Walcott has also received, from Cornell university, for study and illustration, the type specimens used by Prof. C. F. Hartt, in Dawson's 'Acadian geology,' in his descriptions of the fossils of St. John, N.B. All the species described by Professor Hartt will therefore now be illustrated for the first time.

Prof. O. C. Marsh, in charge of vertebrate paleontology for the survey, has had parties working in Wyoming during the past season, and also in the Jurassic of Colorado, and reports to the director that they have made large additions to the collections, and very important discoveries, the results of which will be reported later.

Chemistry. — The chemical division of the survey will hereafter occupy the laboratory of the U. S. national museum, where work will be begun at once on material that has been accumulating in the hands of the chief chemist, Prof. F. W. Clarke.

Professor Clarke has been appointed honorary curator of mineralogy in the U. S. national museum. At the New Haven laboratory, Dr. Carl Barus and Dr. William Hallock are conducting thermo-electric investigations. They find that thermo-electric couples containing nickel behave anomalously at temperatures above 400° C., but that couples of platinum, with palladium or iridium, are available for the measurement of high temperatures. With such couples, temperatures as high as 1200° may be measured as exactly as with the air-thermometer.

Fresh-water shells from the paleozoic rocks of Nevada. — The bed of calcareo-argillaceous strata containing this unusual fauna is situated near the base of the great lower belt of carboniferous limestone of the Eureka mining district, Nevada. The argillaceous layers pass into calcareous strata above, that contain a few plates of crinoidal columns, and fragments of brachiopods, and besides these a fauna of forty or more species that is purely marine, and closely related to that of the lower carboniferous fauna of the Mississippi valley.

Although there is now a large collection of material from the band containing the fresh-water shells that was collected subsequent to the geologic field-work, during which the specimens now to be mentioned were collected, it will not be studied until after the publication of the report on the Eureka district. This brief notice is to call attention to the occurrence of fresh-water shells in the paleozoic rocks, and also to state that more is to be presented when the paleontologic collections shall have been thoroughly worked over and studied.

The first species discovered was a Physa, — a form of the genus so characteristic that there is no need of making any other generic reference; judging, of course, from the shell, and not presupposing that any variation existed in the animal inhabiting it. For this species I have proposed the name Physa prisca (fig. 2). The second is a species so Ampullaria-like that a reference is made to that genus (fig. 3). The operculum is shelly, calcareous, concentric (fig. 3*a*). If not generically identical with Ampullaria, it certainly belongs to the group in a closely allied genus. The name Ampullaria? Powelli is proposed for it. The third species is a pulmonate shell that appears to be closely related to Auricula, and for which the name Zaptychius carbonaria (*nov. gen. et sp.*) is proposed.

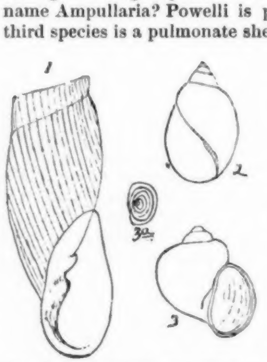


Fig. 1. — Zaptychius carbonaria × 5. Fig. 2. — Physa prisca × 2. Fig. 3. — Ampullaria? Powelli × 2. Fig. 3*a*. — Operculum of A.? Powelli.

A small lamellibranchiate shell that may be a Nucula, Corbicula, or Cyrena, probably one of the two latter, is associated with the above, and also fragments of twigs and small cones that may be referred to the Coniferae. The land-shells thus far described from the paleozoic series are all referable to the sub-order Geophila or terrestrial pulmonates, and comprise six species; viz., Pupa vetusta, P. Bigsbyi Dawson, P. vermilionensis, Dawsonella Meeki Bradley, Zonites (Conulus) priscus Carpenter, Anthracopupa ohioensis Whitfield (from the horizon of the coal-measures), and one species (Strophites grandaeva Dawson) from the erian plant-beds of St. John, N.B. To these we now add two species of the Limnophila (Physa prisca and Zaptychius carbonaria), and one species of an operculated fresh-water shell (Ampullaria? Powelli). It may be said of these species, as Principal Dawson has said of Pupa vetusta, they are remarkable not only for their great antiquity, but also because they are separated by such a vast interval of time from other known species of their race.

Charles D. Walcott.

PUBLIC AND PRIVATE INSTITUTIONS.

Williams college, Williamstown, Mass.

The natural-history department. — Through the liberality of friends, the college has secured a permanent table, with the necessary facilities for its use, in the museum of the U.S. fish-commission at Wood's Holl. The table will be occupied every summer by the department. The college has also leased for a series of years a table at Professor Dohrn's international zoölogical station at Naples, from the use of which it is hoped that permanent benefits will inure to this department. The conditions of the gift of the late Dr. William J. Walker make provision for a scientific expedition every fourth year.

NOTES AND NEWS.

The extensive collections of American Coleoptera made by the late Dr. J. L. LeConte, containing an immense number of original types, become the prop-

erty of the Museum of comparative zoölogy at Cambridge, Mass.

— We reproduce by photo-engraving, from *The photographic news*, a cut prepared from nature by the Luxotype process of the English firm of Brown, Barnes, & Bell. It should be mentioned that considerable clearness has been lost in the reproduction on account of the fineness of the stipple in the original, and the acknowledged hasty printing of the *News*. *The photographic news* has given during the last few months a number of separate imprints from plates made by processes similar to that of Mr. Ives of Philadelphia; that of Sara Bernhardt, in the issue for Nov. 23, being possibly the most satisfactory. Any one interested in the advances in the methods of making relief-plates for printing with type will find much in this series of articles of great interest. The portrait of Dr. LeConte, in this number of SCIENCE, was made by the Ives process, no hand-work having been used in the preparation of the plate from a photograph.

— While we are prosecuting our researches among the mounds, shell-heaps, and pueblos, of our own territory, we must not forget the thorough work going on in India under the patronage of the British government. For about ten years, an archeological survey of the ancient cave and rock-hewn temples of western India has been in operation, and, previously to the present year, three handsome quartos, profusely illustrated, have been published. The third volume treated more especially of the cave-temples of India.

During the present year, volumes iv. and v. have been issued, and complete the report of the survey, extending from 1876 to 1880. These volumes are about the size of the Smithsonian contributions, and are printed on fine paper, and elegantly bound. In volume iv. are forty heliotype plates and twenty-five woodcuts, and in volume v., sixty-one plates and eighteen woodcuts. It is not necessary here to enter into a minute description of these temples, since that has been done by Mr. Fergusson and Mr. Burgess, in their 'Cave-temples of India,' published in 1880. The method pursued is purely technical, "enabling the architect and the student to form a tolerably correct idea of the style and character of the plans and ornamentation. The facsimiles and translations of the inscriptions will afford fresh materials of a trustworthy character for the epigraphist and philologist." The principal group of rock-temples of western India is the magnificent series at Elura, consisting of splendid representatives of the three classes, Baudha, Brahmanical, and Jaina cave-temples. The village of Elura is in the Nizam's territory, about fourteen miles west of Aurangâbâd. Of this group, M. Baudrillart says, "All commentary grows pale before these magnificent ruins. Here the development of the plastic arts and of public religious luxury amongst the Hindus receives the most striking attestation in the magnificence of these temples, in the infinite diversity of their details, and the minute variety of their carvings."

— The Ottawa field-naturalists' club held the first *soirée* of their winter course on Thursday, Dec. 6, when the president, Dr. H. B. Small, delivered his inaugural address. After remarks on the past operations of the club, and suggestions as to its future management, he gave an excellent summary of past and present systems of the classification of the animal kingdom. The necessity of a knowledge of this character was strongly urged, in order that a just conception might be obtained of the relations of the different members of our fauna, and narrowness be avoided by those pursuing special studies. In his opinion, many persons who commenced the study of natural history abandoned it after a short time solely because, through ignorance of the relations of various objects, they failed to become imbued with that love of nature which the more carefully educated student possesses. An interesting discussion ensued on the address, in which several members shared. His excellency the Marquis of Lansdowne, governor-general of Canada, has consented to become patron of the club.

— At the annual meeting of the Boston zoölogical society, held Dec. 4, 1883, the following officers were elected for 1884: president, F. C. Bowditch; vice-president, F. H. Brackett; secretary, R. Hayward; treasurer, A. C. Anthony; librarian, H. Savage.

— In the Iowa weather bulletin for November, attention is called to "The most beautiful phenomena of the entire month . . . the varying and brilliant tints of sunset during the last five days of the month." These brilliant sunsets seem to have been noticed over the whole country.

The prediction is made, that "the winter now beginning will probably be a moderate or mild winter for Iowa and the adjacent parts of the northwest. The observations of the past ten years make the above probability very high, and, taking into account the entire series of forty years' observations, the chances for this winter proving a severe one are less than one in twenty."

— One of the most excellent of the familiar British museum catalogues is that lately published of the Batrachia, Gradientia, and Apoda, in the British museum, by Mr. George A. Boulenger. This work is called a 'second edition' of the catalogue of the same animals, published in 1850, by Mr. John Edward Gray; but it is a second edition only in name, as very little of Gray's work remains in it. The material studied by Boulenger (comprising ninety-seven of the one hundred and thirty-three species recognized, instead of forty-three) is far greater than that at Gray's disposal, and the character of the work done by the younger author is far higher.

The classification adopted by Boulenger agrees in many respects with that of Professor Cope; but some of the families and genera adopted by the latter are here given lower rank. The commonly accepted rules of zoölogical nomenclature are carefully followed by Mr. Boulenger, who evidently does not consider his own whims or prejudices, or even the traditions of the British museum, as forming a law higher than the law of priority.

Among the changes of current nomenclature considered necessary by Mr. Boulenger, we may note the substitution of the generic name 'Molge Merrem' for the later 'Diemyctylus' or 'Notophthalmus,' for our common red or green newt or 'evet;' of 'Cryptobranchus Leuckart' for the 'hellbender,' instead of the later 'Menopoma;' and of the name 'Necturus maculatus Raf.' for the 'mud-puppy,' instead of 'Menobranchus' or 'Necturus lateralis.'

An instructive discussion is given of the geographical distribution of the Batrachia, the geographical divisions with that group coinciding very closely with those recognized in the distribution of the fresh-water fishes.

— The Society of naturalists of the eastern United States will hold its second meeting at Columbia college, New-York City, Dec. 27, at ten A.M.

— Gen. Richard D. Cutts, first assistant superintendent of the U. S. coast-survey, died at Washington, Dec. 13, at the age of sixty-six. Gen. Cutts was born in Washington, and was connected with the coast-survey the greater part of his life. During the war he served on the staff of Gen. Halleck.

— On the 25th and 26th of October, there fell at Hilo, Hawaii, $17\frac{15}{100}$ inches of rain in twenty-two hours, by rain-gauge.

— The December number of *Van Nostrand's engineering magazine* contains an announcement, that, as the publication of the magazine has continually entailed a loss, the magazine will not be continued after the coming year, unless an increased support should justify it. That a magazine of such great merit should succeed is most heartily to be wished.

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